

Federal Environmental Assessment and Review Process

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Federal Environmental
Assessment Review Office

RABBIT LAKE
URANIUM MINING
A-ZONE, D-ZONE,
EAGLE POINT

Report of the
Environmental
Assessment Panel

November 1993



Federal Environmental
Assessment Review Office

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Alberta Environment
Government of Alberta

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Cat. No. En105-51/1993E

ISBN 0-662-21162-6

AVX3789

**RABBIT LAKE URANIUM MINE
ENVIRONMENTAL ASSESSMENT PANEL**

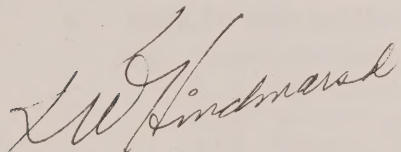
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In accordance with the terms of reference issued in November 1991, the Environmental Assessment Panel has completed its review of the proposed development of the uranium mining facility at Rabbit Lake in northern Saskatchewan. On behalf of the panel, I am pleased to submit this report for your consideration.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'K. Wayne Hindmarsh', is written over a light, circular embossed seal.

K. Wayne Hindmarsh
Chair
Rabbit Lake Uranium Mine
Environmental Assessment Panel

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EXECUTIVE SUMMARY

In November 1991, a federal environmental assessment panel was appointed to examine the environmental, health, safety and socioeconomic impacts of the proposed development of uranium mining at Rabbit Lake in northern Saskatchewan. The proposal involved two open-pit operations in the Collins Bay A-zone and D-zone and full-production underground mining at Eagle Point.

The panel held public hearings on the proposal in June and July 1993. This report is based on submissions made at the hearings and on other public documents presented to the panel.

This report to the Minister of Natural Resources and the Minister of the Environment addresses the acceptability of the proposal in light of its environmental and socioeconomic impacts. The conclusions and recommendations that the report presents will assist the Atomic Energy Control Board (AECB) in deciding whether to approve all or part of the proposal with or without conditions attached.

Full-production underground mining at Eagle Point would employ techniques developed and tested during exploratory activities at this site. The mining methods proposed are consistent with safe operational standards and have the potential to mitigate adverse environmental impacts. This fact, as well as the safe and sound procedures practised at Eagle Point to date, leads the panel to recommend that the AECB approve full-production mining at Eagle Point. It must be stressed that this approval should be subject to the conditions detailed in the report. These conditions are designed to ensure that the mining is safe, environmentally benign and fully monitored.


The information presented to the panel on waste-rock management and decommissioning plans for the A-zone and D-zone open-pit operations is insufficient to determine whether the environmental effects of these operations are acceptable. Comprehensive studies are required to yield the data necessary for assessment of the plans. The panel therefore recommends that mining of the A-zone and D-zone

orebodies not proceed until the required studies are completed and the specific issues identified in the report are resolved.

It is clear to the panel that greater public involvement in the regulatory regime governing the Rabbit Lake operation is imperative to restore public trust in the process. Creation of an Environmental Management Committee with members from the public, including Athabasca Basin communities, and government is an essential means to achieve this goal. The committee would provide valuable advice on key engineering and environmental issues, such as designing and implementing the monitoring program. The panel concludes that establishment of an Environmental Management Committee is an essential condition of approval and recommends that the AECB take immediate steps to form such a committee.

The panel's overall review of current monitoring activities at the Rabbit Lake site indicates that there is a need for a more effective program that focuses on ecological systems. The monitoring program would utilize scientific standards and quality control techniques to yield the data required to establish baseline conditions and to fully assess the short- and long-term environmental effects of the operation. The panel thus recommends that the Environmental Management Committee, in collaboration with the AECB and the proponent, develop and implement this type of monitoring program.

The proposal raises a number of socioeconomic issues, including job opportunities, economic benefits to Athabasca Basin communities, the quality of working life and proponent-community relations. The panel addresses these issues in the report and makes a number of proposals about them. There is, however, one concern that should be highlighted: the need for improved relations between the proponent and the Athabasca Basin communities, especially Wollaston Lake. The panel notes that there has been progress in this area recently; however, there is still ample room for greater efforts by the parties to foster a climate of trust and cooperation.



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1 INTRODUCTION

1.1 Project Description

The Rabbit Lake Joint Venture (proponent), an undertaking of Cameco Corporation and Uranerz Exploration and Mining Limited, is proposing to mine three new uranium orebodies at the Rabbit Lake operation in northern Saskatchewan. The proposal calls for full-production underground mining of the Eagle Point orebody and open-pit mining of the Collins Bay A-zone and D-zone orebodies.

The Rabbit Lake operation is on the western shore of Wollaston Lake, about 100 km west of the Manitoba border and 200 km south of the Northwest Territories (Figure 1). The three orebodies are located along the northwest shore of Harrison Peninsula on Collins Bay (Figure 2). The closest community is the Hamlet of Wollaston Lake (Hatchet Lake Band), 40 km away on the eastern shore of Wollaston Lake.

Rabbit Lake, the oldest operating uranium mining and milling facility in Saskatchewan, started producing ore from open-pit mining of the Rabbit Lake orebody in 1975. Exploration of the area surrounding the Rabbit Lake orebody identified several additional radioactive occurrences, including the Collins Bay A-zone, B-zone and D-zone and Eagle Point deposits. Following completion of mining at the Rabbit Lake pit in 1984, open-pit mining of the Collins Bay B-zone took place from 1985 to 1991. The Rabbit Lake mill is currently processing ore stockpiled from the B-zone mine. This ore supply is predicted to be exhausted by May 1994.

The Eagle Point deposit, 13 km north of the Rabbit Lake mill, is largely under the bed of Collins Bay. Cameco plans to develop the Eagle Point orebody as an underground mine in three phases: engineering feasibility and approvals (phase 1); underground exploration and test mining (phase 2); and full-production mining (phase 3). The first phase has been completed, and test mining (phase 2) has been under way since 1991.

The test mining phase requires construction of an access ramp or decline, horizontal tunnels and a ventilation system. The proposed mining method is vertical blast-hole stoping with delayed fill. This method involves opening a drift or tunnel along the top of the orebody to reach the ore and a second drift below to remove the ore. The drifts are constructed in waste rock to reduce worker exposure to radiation. A large-diameter hole, or slot raise, is drilled through the orebody from the lower drift. The detonation of explosives in the drilled blast holes breaks the ore into the slot raise, where it collects at a draw point. To reduce worker exposure to radiation, the ore is hauled away using remote-controlled scoop trams. After the ore is removed, the stope is filled with a mixture of waste rock and cement to stabilize the ground and supply wall support for adjacent stopes.

The A-zone and D-zone orebodies are 12 and 10 km respectively from the Rabbit Lake mill. Cameco plans to mine these orebodies using the same techniques that were employed for the B-zone orebody. Since these orebodies are largely underwater, dykes of interconnected, rock-filled, steel sheet-pile cells would be constructed around each orebody. Water would

then be pumped out of the dyked area, and the orebodies would be mined by conventional open-pit methods. It is estimated that each orebody would be mined over one winter. Initial plans are to place most of the waste rock from mining the A- and D-zones on an existing pile of waste rock from the B-zone (Figure 2).

The Rabbit Lake mill would process Eagle Point, A-zone and D-zone ore. A by-product of the milling process is tailings, which consist of finely ground rock and chemical precipitates. Tailings from milling B-zone ore have been placed in the mined-out Rabbit Lake pit, which was converted to a tailings containment facility. The proponent plans to dispose of tailings from milling Eagle Point, A-zone and D-zone ore in the same facility.

Water removed from the Rabbit Lake tailings pit and the three new mines would be pumped to the mill and treated prior to discharge into Effluent Creek, which flows into Hidden Bay (Figure 2). Cameco has developed preliminary decommissioning plans for the three new mining operations and the Rabbit Lake tailings pit.

1.2 Review Process

In 1987, Cameco submitted to federal and provincial regulatory agencies an Environmental Impact Statement (EIS) concerning a project to mine three new orebodies. The project was approved under the *Saskatchewan Environmental Assessment Act* on January 4, 1988. Subsequently, the Saskatchewan government reviewed Cameco's submissions to this review and on June 7, 1993, advised the panel that the project conformed with the terms and conditions in the existing ministerial approval.

The Atomic Energy Control Board (AECB) is the federal agency responsible for the administration of uranium mining and processing. Following a review of the 1987 EIS, the AECB determined that the environmental effects of the proposed developments were mitigable with known technology and, in April 1988, issued a licence for test mining of the Eagle Point orebody.

In April 1991, the federal Minister of Energy, Mines and Resources (now Natural Resources) referred the proposed development of the uranium mining facility at Rabbit Lake to the federal Minister of the Environment for a panel review. The referral was made in accordance with Section 13 of the *Environmental Assessment and Review Process (EARP) Guidelines Order* due to public concern about the proposal.

In November 1991, the Minister of the Environment appointed the Rabbit Lake Uranium Mine Development Panel (panel). Members of the panel were Dr. K. Wayne Hindmarsh (chair), Dr. Dennis Lehmkuhl, Dr. Ronald Martin and Mr. Charles Pelley. Their biographies are in Appendix A. Prior to the public hearings phase, Mr. Pelley resigned from the panel for medical reasons. During the public hearings, Mr. Wayne Clifton provided technical advice on engineering issues pertaining to uranium mining. A complete list of members of the panel secretariat and technical specialists is in Appendix B.

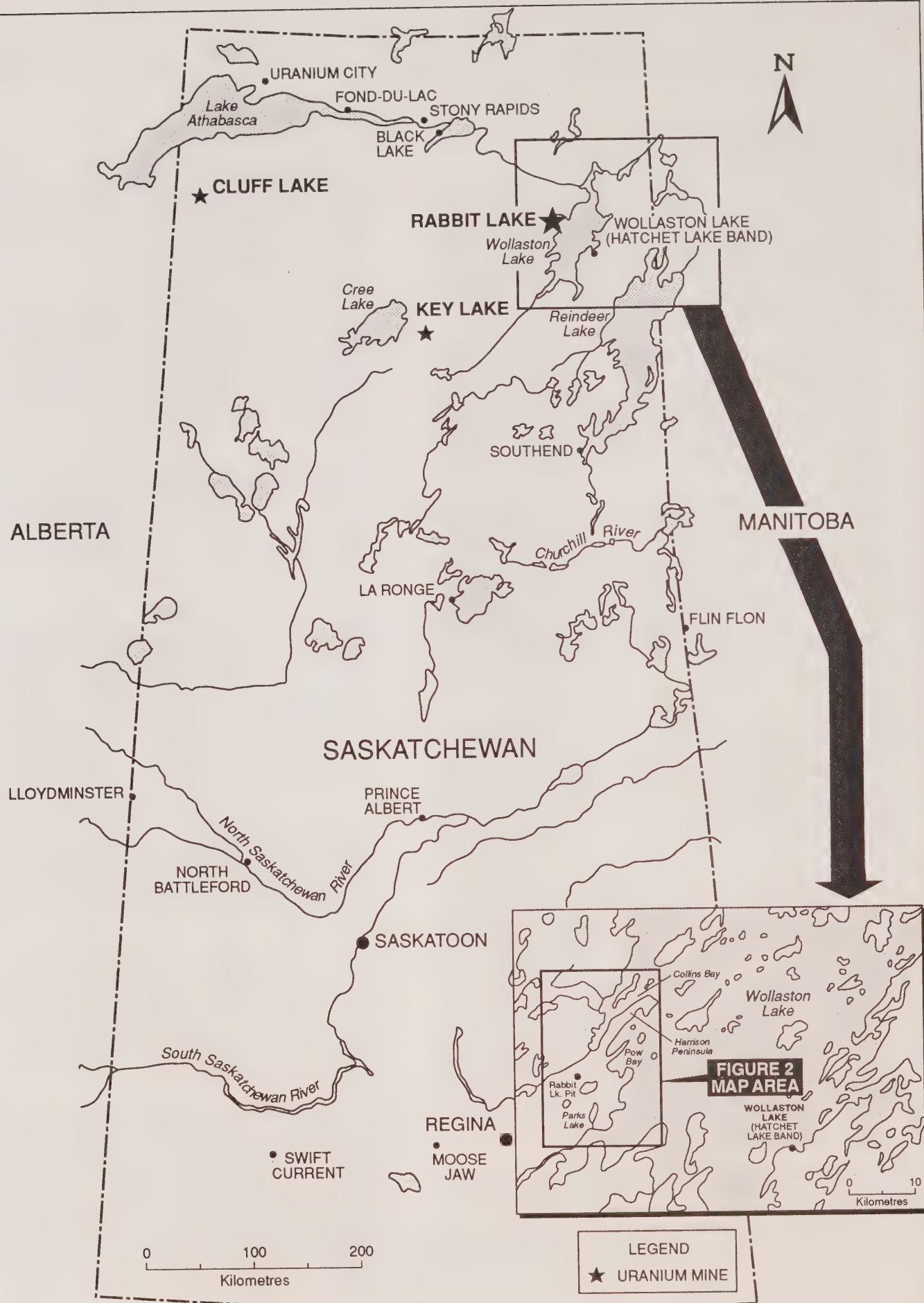


FIGURE 1 : LOCATION OF RABBIT LAKE OPERATION

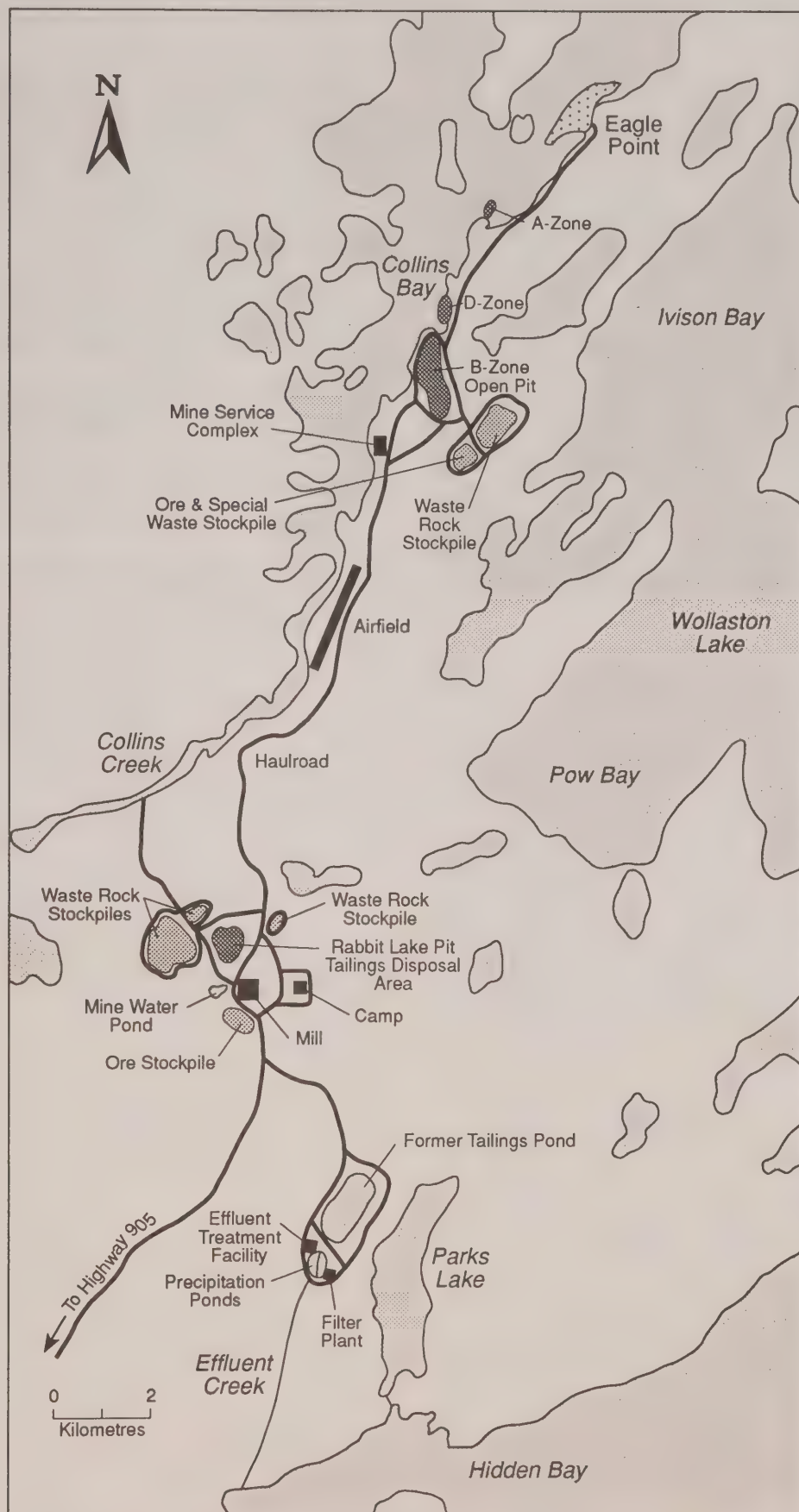


FIGURE 2 : RABBIT LAKE OPERATION

The panel was asked to review the environmental, health, safety and socioeconomic impacts of the proposed development. Specifically, the panel was to review the short- and long-term impacts; the cumulative impacts of the existing operation and the proposed development; the employment and socioeconomic opportunities for northern residents; the adequacy of measures to protect environmental quality and to safeguard worker health and safety; the adequacy of monitoring, enforcement and compliance systems; and the benefits afforded by the proposal. Complete terms of reference for the panel are in Appendix C.

Following appointment of the panel, Cameco updated the 1987 EIS and submitted it to the panel in June 1992. The panel provided a 105-day review period to allow the public, government agencies and technical specialists to study the EIS and provide comments. During this review period, the panel held community meetings in Wollaston Lake, Stony Rapids, Black Lake, Fond-du-Lac and Uranium City to describe the review process to communities in the Athabasca Basin and to identify issues important to these communities. In November 1992, after reviewing the EIS and considering comments received, the panel issued a request for additional

information. In response, Cameco issued an Addendum to the EIS in March 1993. After a 30-day review period, the panel determined that there was sufficient information to proceed to public hearings. At the same time, the panel requested information on six additional areas. This request was answered by Cameco's "Response to Panel Questions and Concerns on the Addendum." A bibliography of the review documents is in Appendix D.

The public hearings gave review participants an opportunity to present their views, opinions and technical information on the acceptability of the proposal. Thirteen days of hearings were held between June 8 and July 5, 1993 in Wollaston Lake, Black Lake, Fond-du-Lac, La Ronge, Prince Albert, Saskatoon and Regina (Appendix E). The panel received more than 130 submissions during this phase (Appendix F).

This report is the final step in the panel review process. It provides the panel's findings, conclusions and recommendations to the federal Ministers of the Environment and Natural Resources.

A glossary of terms used in this report is in Appendix G.

2 OVERALL PROJECT FINDINGS, CONCLUSIONS AND MAJOR RECOMMENDATIONS

During the course of this review the panel received information on many aspects of the proposal, including aspects that were outside its mandate. The major issues that the panel addressed are discussed in the following sections: Project Engineering Issues (3), Environmental Issues (4), Socioeconomic Issues (5), Health and Safety Issues (6), and Monitoring, Enforcement and Compliance Issues (7).

This section presents the panel's overall project findings, conclusions and recommendations on mining of the Eagle Point, A-zone and D-zone orebodies and on public involvement in this development.

Project Engineering Issues

Mining has been conducted at the Rabbit Lake site since 1975 and the proposed development would be an extension of an existing operation. Mining of the A-zone and D-zone orebodies would use the same techniques as were used for the B-zone orebody. The existing mill would process Eagle Point, A-zone and D-zone ores, and the Rabbit Lake tailings pit would be used to dispose of tailings from the milling operation. Although the technique proposed for Eagle Point would be a new mining technique for the Rabbit Lake site, test mining since 1991 has given Cameco considerable information on environmental impact, the safety of the underground mine structure, and the protection of workers from radiation risks.

Although information on the environmental effects of the Rabbit Lake operation is available, the prediction of long-term potential impacts depends on modelling. For example, the selection of final waste-rock management options and decommissioning strategies and the prediction of contaminant transport all depend on models. Two key issues related to modelling at the Rabbit Lake site arose. First, the panel was advised that information on the basic geology and hydrogeology of the site was limited. As a result, the models were often based on conservative assumptions and were not calibrated with site data. Second, in a number of cases, field results have not been used to validate the models. Given that the site has been operational for more than 15 years, there have been a number of opportunities to obtain the data necessary for model validation.

The panel concludes that Cameco has demonstrated the ability to adequately manage the proposed development of the Eagle Point orebody. Results of test mining since 1991 indicate that the proposed mining methods are feasible and have the potential to mitigate adverse environmental effects. The Rabbit Lake tailings pit is the most appropriate option for disposal of tailings produced by milling Eagle Point ore. Viable decommissioning plans for the Eagle Point mine and waste rock have been presented. However, a more comprehensive approach to data collection and analysis is necessary to address the long-term concerns related primarily to tailings management and decommissioning. Requirements for specific

information on these aspects of the proposal are in "Project Engineering Issues" (Section 3).

The panel found that there are a number of unresolved issues related to the mining of the A-zone and D-zone orebodies. For instance, the characteristics of A-zone and D-zone waste rock including contaminant levels and acid generation potential have not been determined. Further, the proponent has not been able to demonstrate that the existing B-zone pit and waste-rock pile can be successfully decommissioned, yet has proposed a similar decommissioning approach for A-zone and D-zone. The panel recognizes that Cameco has made a commitment to address these issues. Nevertheless, the panel must conclude that it has insufficient information to recommend whether mining of the A-zone and D-zone orebodies should proceed. Requirements for specific information related to the proposed A-zone and D-zone developments are in Section 3.

Environmental Issues

Full-production mining at Eagle Point is unlikely to result in any significant disturbance to the surrounding environment since mining will be underground. The main environmental issues related to this aspect of the development are tailings disposal, continued flow of mill effluent into Hidden Bay and decommissioning. Based on current and predicted performance of the operation, the panel concludes that impacts are either insignificant or mitigable. However, a comprehensive baseline study and monitoring program would be required to confirm that these predictions are correct and to identify impacts not predicted so that they could be addressed. The panel has concluded that there is insufficient information to assess the environmental impacts of developing the A-zone and D-zone orebodies.

The environmental monitoring program received considerable attention at the hearings. Cameco used the results of its monitoring program to support its claim that the operation has had very little effect on the local environment. Further, this record formed the basis of its prediction that impacts of the proposed developments would be minimal. Government agencies, environmental interest groups and northern communities criticized the program for its lack of an adequate baseline, poor quality control/quality assurance and improper selection of sampling sites. The panel concludes that, although the monitoring program meets the requirements of the regulatory agencies for compliance monitoring, it is not contributing to an overall understanding of the effects of the operation on the environment. Moreover, the monitoring program has not assured the public and northern communities that the project has not and will not cause ecological damage. The panel has made recommendations for development of an ecosystems-based monitoring program in "Environmental Issues" (Section 4).

Socioeconomic Issues

Cameco is committed to the employment of northern and aboriginal people from the remote communities of northern Saskatchewan. In 1992, 44% of the proponent's labour force consisted of northerners, with 40% being of aboriginal ancestry. Cameco made a commitment to increase the percentage of northerners in its workforce to 50% by 1995. There are recognizable benefits to northern communities as a result of this high proportion of northern employees; however, Athabasca communities expressed the view that they should receive a greater share of the benefits. The panel suggests that Cameco should make every reasonable effort to achieve the 50%-northern goal and should consider other initiatives such as joint ventures to augment economic benefits to Athabasca Basin communities. Cameco has made a considerable effort to provide on-the-job training, which will develop skills that can be transferred to other jobs within the operation or to other working situations. Educational initiatives have also been undertaken which have been and will continue to be of benefit. The panel concludes that overall the socioeconomic effects of this proposal are positive and that negative impacts are mitigable.

Health and Safety Issues

The panel recognizes that the perception of risk to the environment is an important issue particularly for northern people who are closest to the mine. The concerns include damage to the land, contamination of the aquatic environment and loss of opportunities to harvest fish and wildlife. The panel concludes that this perception may be changed by community input to monitoring of the operation and by the use of traditional ecological knowledge in the monitoring programs.

Cameco is dedicated to mine safety and radiation protection and has demonstrated that workers' levels of radiation exposure would be below the accepted limits. On the basis of information provided by both the proponent and by government agencies, the panel is satisfied that the radiological impact of the proposed development on the surrounding communities would be acceptable.

Overall Conclusions and Major Recommendations

The following overall recommendations must be viewed along with the panel's specific recommendations related to project engineering, environmental, socioeconomic, health and safety, and monitoring, enforcement and compliance issues.

Based on the documentation provided to the panel and the information gathered throughout the public hearings, the panel concludes that full-production development of the underground mine at Eagle Point could proceed without significant environmental, socioeconomic, health and safety effects.

- 1. The panel recommends that full-production underground mining at Eagle Point be allowed to proceed under the conditions described within the report.**

The panel concludes that there is insufficient information to reach an informed decision on the environmental effects of mining the A-zone and D-zone orebodies.

- 2. The panel recommends that mining of the A-zone and D-zone orebodies not proceed until information on waste-rock management and decommissioning is obtained and until Cameco has demonstrated that both short- and long-term adverse environmental impacts are mitigable.**

Public Involvement

Whereas the panel has made recommendations regarding mining of the Eagle Point, A-zone and D-zone orebodies, it recognizes that many aspects of these developments cannot be definitely or completely resolved through the panel review process. Aspects such as waste-management options, decommissioning strategies and monitoring requirements evolve over the course of the operation. As data are gathered and operational proposals made, the regulators evaluate this information and implement their decisions through a staged licensing process. Resolution of these issues requires a longer timeframe than is available to the panel.

Primary responsibility for the regulation of uranium mining in Saskatchewan rests federally with the AECB and provincially with Saskatchewan Environment and Resource Management. A focus of the regulatory process is a Joint Review Group composed of these agencies and Environment Canada. This group provides a mechanism for coordinated government review of the Rabbit Lake operation and determination of licensing requirements.

The panel heard that the public is concerned about what it perceives to be the closed nature of the regulatory process. There seemingly is little opportunity for public input or for the public to be informed in a timely manner of results of monitoring programs, operational changes proposed by the proponent or licensing decisions. Other concerns were raised about the quality of baseline data and the scope of the environmental monitoring program. It is clear to the panel that changes to the present regulatory decision-making process for the Rabbit Lake operation are warranted to address deficiencies regarding both public involvement and data quality.

The panel concludes that participation of the public, in particular the Athabasca Basin communities, in the decision-making process for the Rabbit Lake operation is essential to improving public trust in the regulatory regime. At the same time, the panel acknowledges that the regulatory agencies have a legal responsibility for the management of uranium mining and in no way wishes to diminish or compromise this responsibility.

The question then is how to provide for public input in the decision-making process while recognizing the legal responsibilities of the regulatory agencies. The structure of the existing Joint Review Group should be considered as the starting point in developing an improved decision-making framework. The purpose of modifying the process is to improve the quality of

information available to those agencies responsible for regulating the industry and to make the regulatory process more responsive to public concerns.

3. The panel recommends that the Joint Review Group be restructured and expanded to create an Environmental Management Committee for the Rabbit Lake operation. The panel recommends that the AECB consult directly with stakeholders to establish the nature of their representation. Further, non-governmental participants should be compensated for their time and out-of-pocket expenses. The panel suggests that funds collected by government from the industry be used to finance these expenses.

The panel has recommended that the stakeholders, in consultation with the AECB, should ultimately determine the membership and structure of the Environmental Management Committee. The parties may find it advantageous to use a neutral third party to help establish the process and to facilitate the selection of participants for the Environmental Management Committee. The panel concludes that in order for the committee to be effective, the following should be considered for membership:

- present members of the Joint Review Group;
- Athabasca Basin communities, including Wollaston Lake;
- informed environmental interest groups, for example, the Saskatchewan Environmental Society;
- the scientific community; and
- other federal departments, for example, Fisheries and Oceans and Health.

The panel considers it important that aboriginal elders and women be represented either directly or indirectly on the committee. The panel proposes that Cameco attend many but perhaps not all of the Environmental Management Committee meetings to inform the committee of activities at the Rabbit Lake site and to discuss proposed operational changes.

The mandate of the Environmental Management Committee would be to provide timely and relevant advice on key engineering and biophysical issues related to the Rabbit Lake operation; to ensure high standards of scientific analysis; to provide a forum for identifying and addressing public concerns; and to communicate information on these issues directly to the stakeholders. The committee may also wish to examine the nature of the regulatory process and explore ways to reduce duplication. The committee's role would be similar to that of the existing Joint Review Group; however, the committee would consider the broader concerns of the public and other government agencies in a more integrated and coordinated fashion.

To provide advice on engineering and biophysical issues pertaining to the Rabbit Lake site, the committee should specifically address baseline conditions, monitoring, waste-rock management, tailings management, decommissioning and post-decommissioning strategies, water use, cumulative impacts, and research needs. Specific information needed in

these areas is identified in "Project Engineering Issues" (Section 3) and "Environmental Issues (Section 4). A key responsibility of this committee would be to ensure that the information collected on the Rabbit Lake site is of high quality and that this information is efficiently and effectively communicated to the public.

The panel recommends that meetings of the Environmental Management Committee be open to the public and that minutes of meetings be publicly available and distributed to interested parties. The panel also suggests that the Environmental Management Committee consider producing an annual report documenting the status of important activities at the Rabbit Lake site and its recommendations regarding these activities. This report should be written so that it can be understood by the public, with summaries translated into Dené and Cree. The panel suggests that the committee should periodically evaluate its performance to ensure that it is fulfilling its mandate and is an effective tool for providing public input to the regulatory process.

Government funding to support the participation of the public, particularly northern communities, has been recommended. In addition to compensation for out-of-pocket expenses and time, the panel proposes funding of independent experts to advise the committee on specific issues. The panel is aware that funds are scarce and wants to ensure that the committee does not strain limited resources. The committee may, in fact, help save money by reducing duplication in the regulatory process. Further, a critical examination of the monitoring program could identify areas where savings are possible. Finally, if the committee is effective, it should eliminate the need for further public reviews, which are costly in both time and dollars.

The panel concludes that providing representation for residents of the Athabasca Basin on the Environmental Management Committee will not be sufficient to address their fundamental concerns about the effects of the proposal on the environment. These communities have clearly stated that they want much more direct involvement, particularly in the monitoring program. Ultimately, this involvement could include collection and analysis of environmental and socioeconomic data.

4. The panel recommends that the Environmental Management Committee and the proponent determine and implement mechanisms for greater community involvement in the monitoring program.

The panel notes that the Department of Fisheries and Oceans has involved northern residents in monitoring programs. This experience will assist in the development of similar programs in the Athabasca Basin. The panel also encourages the proponent to pursue proposals, such as heard from the Environmental Monitors of the Athabasca Region, to develop community-based monitoring programs.

Finally, the panel realizes that effective participation of northern communities in monitoring programs and on the Environmental Management Committee requires education and training. The panel suggests that schools in the community could work with the proponent and the regulatory agencies to

develop educational programs. The Environmental Management Committee may wish to investigate, with provincial and local authorities, ways to integrate the activities at the Rabbit Lake site into the curricula of community schools. The goal would be to develop individuals in northern communities with the skills and education necessary to actively participate in the monitoring of the Rabbit Lake operation.

- 5. The panel recommends that the AECEB and other appropriate agencies make their services available to the communities to assist in the development and implementation of education and training programs.**

3 PROJECT ENGINEERING ISSUES

During the review, there was considerable focus on the engineering aspects of the Rabbit Lake operation. A primary reason for this focus was that project design and operation will determine the nature and scope of the effects on the environment. Although many aspects of the operation were considered, five areas were of particular concern: waste-rock management, tailings management, decommissioning, water use and safety of the Eagle Point mine.

One issue that relates to all aspects of project engineering is the regulatory approach taken by the AECB, which is responsible federally for the administration of uranium mining and processing. The AECB's approach is to prescribe radiation dose limits that must not be exceeded and to require that the licensee develop its operation in such a manner that the doses are *As Low As Reasonably Achievable* (ALARA). This ALARA principle ensures that operators do more than just meet regulatory standards. During the hearings, several presenters proposed that the ALARA principle should apply not only to radiation dose but to all aspects of the operation. In response, Cameco indicated that, in fact, it follows the ALARA principle in all aspects of project design and operation. The panel supports this approach. In the following sections, the panel makes a number of specific recommendations regarding the application of ALARA to additional development at Rabbit Lake.

3.1 Waste-rock Management

Most of the waste rock (91%) from the Eagle Point mine would be placed back underground. The waste would be cemented and used to back-fill the stopes. Following mining, an estimated 150,000 m³ (broken) of waste rock would be left on the surface at Eagle Point. The proponent's preferred option is to regrade and vegetate this rock since it is predicted to have low levels of contaminants.

It is estimated that mining of the A-zone and D-zone orebodies would produce 376,000 and 589,000 m³ (broken) of waste rock, respectively. Geochemical testing of the waste rock has not been done, but experience with the B-zone pit suggests it is likely to contain significant amounts of nickel and arsenic.

Cameco has proposed several options for disposal of waste rock from the A-zone and D-zone mines. These options involve classifying the waste rock according to levels of arsenic, nickel, sulphur and uranium oxide (U₃O₈) and separating out special waste for specific treatment. In order to develop a waste-rock classification system, studies to characterize the rock are required. These studies have not been conducted; however, for modelling and impact prediction, Cameco proposed the following interim classification scheme.

CONTAMINANT	WASTE ROCK (%)	SPECIAL WASTE (%)
Arsenic	≤0.02	>0.02
Nickel	≤0.02	>0.02
Sulphur	≤0.20	>0.20
Uranium oxide	≤0.03	≥0.03 to ≤0.14

During the hearings, Cameco confirmed that 0.03% uranium oxide would be the cut-off grade for uranium in waste rock at the Rabbit Lake operation. The waste rock would be placed on the existing B-zone waste-rock pile, and the special waste would be placed in the bottom of the mined-out A-zone and D-zone pits. The special waste would be covered with overburden, and water would be pumped into the pits. Depending on the resultant water quality in the pits, the dykes isolating them from Collins Bay might eventually be breached.

A number of presenters commented on the proposed options for waste-rock management. Many expressed concern about adding to the B-zone waste-rock pile, since it is already a potential source of surface and groundwater contamination. Environment Canada proposed that all special waste be isolated in the underground workings at Eagle Point. Further, Environment Canada officials suggested that the A-zone and D-zone pits should be completely filled with waste rock, since it is their opinion that it will not be feasible to obtain satisfactory water quality in the flooded pits.

The proponent and the regulators agreed that the lack of information on the character of waste rock from the A-zone and D-zone made it difficult to evaluate the short- and long-term impacts of various waste management options. To provide this information, Cameco proposed the following five-step program.

- Step 1: Review existing drill logs from the A-zone and D-zone to establish requirements for drill-hole locations and depths.
- Step 2: Conduct a drilling program in the A-zone and D-zone areas; log and sample the drill cores.
- Step 3: Analyze the drill-core samples to determine acid-generating and metal-leaching potential.
- Step 4: Computer model various disposal and decommissioning scenarios to determine the environmental impacts associated with each waste-rock management option.
- Step 5: Prepare a report on the proposed waste-rock management plan for review by government agencies.

Cameco estimated that the above program will be completed in early 1995. The AECB advised the panel that this approach was acceptable and that it should enable the proponent to assess the impacts of managing wastes and decommissioning the two pits.

Several presenters told the panel that a complete understanding of the geology and hydrogeology of the site is lacking. This information is necessary to accurately model and predict contaminant movement and natural retardation in the subsurface system. It was pointed out that waste rock left on the surface following mining of the original Rabbit Lake pit has not been studied in detail, although the proponent did indicate that it would address this as part of an overall decommissioning plan. The panel suggests that since this waste rock has been

exposed for a number of years, it provides an excellent opportunity to examine contaminant movement. The results from such investigations could then be used to improve the quality of the modelling of waste-rock disposal options for the A-zone and D-zone.

The panel has concluded that there is insufficient information to reach a recommendation with regards to mining of the A-zone and D-zone orebodies. The panel therefore urges Cameco to undertake and complete the waste-rock testing and analysis program that it outlined to the panel. Cameco should include in the testing program a comprehensive evaluation of the surrounding soils, geology and hydrogeology to obtain the information necessary to accurately predict contaminant movement. Further, the panel suggests that Cameco consider a broad range of waste-rock management options, including disposal of special waste in the underground workings of Eagle Point.

6. The panel recommends that Cameco develop a waste-rock management plan for the A-zone and D-zone orebodies and that mining of these orebodies not proceed until the plan has been reviewed and approved. The plan should include the following essential elements:

- a) a waste-rock classification scheme that can be justified on the basis of environmental protection and on meeting the ALARA principle;
- b) confirmation that the proposed classification scheme will separate waste rock reliably from special waste and ore;
- c) impact predictions that fully consider the conditions in the natural environment that will receive the waste; and
- d) monitoring requirements to determine if the predictions are correct, to identify impacts not predicted and to provide data for the development of decommissioning plans.

It is the panel's view that the Environmental Management Committee should take an active role in the review of the waste management plan and that the committee would provide the mechanism for public input to the review. To fully evaluate the waste-rock management plan proposed by Cameco, the committee will need a set of criteria. These criteria could include: water quality objectives if the pits are to be flooded; site-specific water quality criteria for Collins Bay; and performance standards for waste-rock sorting.

7. The panel recommends that the Environmental Management Committee develop criteria to evaluate the proposed waste-rock management plan.

Given that the waste-rock management scheme will not be presented until early 1995, the committee has adequate time to develop the evaluation criteria. In fact, it would be desirable if the committee were to develop such criteria and provide them to Cameco before its testing and analysis program were completed.

3.2 Tailings Management

Tailings produced from milling Eagle Point ore and, if approved, A-zone and D-zone ore would be placed in the Rabbit Lake tailings pit. The tailings, which consist of finely-ground rock and chemical precipitates from the milling process, will contain minor amounts of radionuclides, including uranium, radium and polonium, and unleached portions of other metals. The Rabbit Lake tailings disposal system has an innovative "pervious surround" design. The objective of this design is to produce a consolidated, highly impermeable mass of tailings within a highly permeable envelope. After the tailings pit is decommissioned, groundwater is predicted to follow the path of least resistance and flow around, rather than through, the tailings. The tailings pit is licensed by the federal and provincial governments and has been in operation since 1985. A total of approximately 2,700,000 tonnes of tailings had been deposited in the pit by the end of 1992.

Before tailings were placed in the mined-out Rabbit Lake pit, a pervious envelope was prepared by placing a layer of crushed rock on the bottom and side walls of the pit. A layer of sand placed inside the crushed rock acts as a filter to prevent the tailings from entering and thus clogging the pervious layer. Tailings were initially placed in the pit in the form of a filter cake. Subsequently, tailings were in the form of a slurry containing approximately 40% solids. The pervious surround provides a seepage path for pore water, thus promoting consolidation of the tailings. The pore water is collected in a sump at the base of the pit and pumped back to the mill for treatment.

When milling is completed and all tailings have been placed in the pit, the excess pore water will be removed, leaving a consolidated mass of tailings with low permeability. Pumping will then cease, and the natural water table will be allowed to reestablish itself. Elimination of the pore water should remove the driving force that could expel contaminants from the tailings. After decommissioning, molecular diffusion is predicted to be the only remaining contaminant-release mechanism. The rate of diffusion is anticipated to be slow enough that surrounding water quality would not be affected.

Since the tailings will contain radioactive materials and heavy metals, considerable concern was expressed at the hearings about the ability of the tailings facility to contain these materials over the long term. The panel was advised that the pervious surround method was the most appropriate technology for containing tailings and had a number of advantages over surface tailings disposal. However, the pervious surround method is relatively new and considered by some presenters to be experimental. Further, a pervious surround tailings management system has never been decommissioned; hence, predictions on the long-term containment abilities of the pit are based solely on modelling.

The level of uncertainty in the predictions could be reduced if the models were calibrated with site-specific measurements of the physical environment and validated based on performance of the tailings pit to date. The results of the monitoring programs have allowed some validation of the modelling.

Cameco reported that consolidation of the tailings has occurred more rapidly than predicted. This supports the view that knowledge of the system's functioning is incomplete or that the models require revisions, or both. The panel was told that the contaminant migration models had not been calibrated with site-specific conditions. In response, the proponent indicated that there were opportunities on the site to calibrate and validate the models prior to site decommissioning.

Two specific issues that could affect the operation of the tailings disposal facility were raised. There is some evidence that ice lenses have formed within the tailings. If these areas of ice remain following decommissioning, they could have a detrimental effect on surrounding water quality since they could thaw and expel contaminated pore water. Cameco advised the panel that several techniques could reduce this problem; for example, providing additional snow or water cover to insulate the tailings and thereby reduce freezing, or subaqueous deposition of the tailings in the centre of the facility. Another issue that could affect the functioning of the system is segregation of the tailings. If the tailings are discharged over a large area, the coarser fractions settle out in the upstream portion and the finer particles settle out in the downstream portion of the tailings pit. The result is that permeabilities are relatively high in upstream portions and low in the downstream area. Areas of low permeability would retain pore water longer, which might result in areas of frozen tailings. Tests at Rabbit Lake indicate that segregation of tailings is occurring. Cameco indicated that it can manage this problem by maintaining a relatively high solids content in the slurry, keeping the tailings beach short, and periodically rotating the discharge points.

The panel concludes that the Rabbit Lake tailings pit appears to be the most appropriate tailings disposal option. Information presented to the panel indicates that the pit seems to be functioning largely as predicted. However, since the pit represents a new and untested approach to tailings management, a detailed monitoring program is essential to calibrate the models, to verify model predictions, and to identify conditions not predicted so that they can be addressed. This program could be conducted in parallel with mining at Eagle Point.

Cameco informed the panel that the current monitoring program for the tailings pit includes quality control of the pervious envelope materials; measures tailings settlement and pore-water pressure; samples tailings to determine their properties; samples and analyzes water pumped from the pit; and samples and analyzes the surrounding groundwater. During the hearings, concerns were expressed that some aspects of the monitoring program were not being implemented quickly enough, that the public had difficulty obtaining results from the monitoring program, that modelling has not been sufficiently validated with field measurements, and that a comprehensive program to define the surrounding geology, hydrology and geochemistry is lacking. Specific concerns were that models are based on laboratory rather than field measurements of tailings permeability; the surrounding rock is assumed to be a homogeneous mass, whereas several geologic strata are known to exist; and sampling of water pumped from the pit

does not give an accurate measure of pore-water quality since it is a mixture of pore water, groundwater and surface runoff.

8. The panel recommends that Cameco implement a comprehensive monitoring and assessment program for the Rabbit Lake tailings pit. As part of this program, Cameco should undertake the following tasks.

- a) **Assess whether the properties of the tailings are consistent with those used when the facility was designed.**
- b) **Calibrate and update predictive models on contaminant transport in the receiving environment using data from field testing of the B-zone tailings, Rabbit Lake tailings, Rabbit Lake waste rock and B-zone waste rock.**
- c) **Determine the appropriate tailings' properties, including permeability and porosity, by field testing.**
- d) **Determine the permeability and relevant hydraulic properties of all surrounding rock units by field testing.**
- e) **Define the quality of pore water in order to estimate the quality of water that may reach the receiving environment.**
- f) **If the water cover option were to be selected for decommissioning the pit, predict the long-term quality of surface water and surrounding groundwater using three-dimensional flow or geochemical models.**
- g) **Maintain a detailed inventory of the chemical and physical characteristics of tailings deposited in the facility.**

The panel has recommended that the Environmental Management Committee play a key role in the development and implementation of the Rabbit Lake tailings pit monitoring and assessment program. Further, the committee should review results of this program and, if necessary, recommend changes in tailings management to ensure that the pit is not causing significant adverse environmental impacts.

3.3 Decommissioning

The panel's mandate includes an examination of impacts of the proposed development during the decommissioning and post-decommissioning phases. It is difficult to address this aspect in detail at this time, since decommissioning proposals are largely conceptual. A number of issues raised during the review need to be considered before decommissioning plans can be finalized. The proponent indicated that it needs more data and modelling before it can develop final decommissioning plans. The panel concludes that involvement of the Environmental Management Committee in the development of decommissioning plans is essential to ensure that public concerns about this phase of the operation are fully addressed.

Eagle Point

An estimated 1 million tonnes of waste rock would be left on the surface following mining of the Eagle Point orebody. Cameco indicated that it plans to undertake a waste-rock characterization program and model potential impacts. If modelling indicates that the waste rock would result in significant contamination, then capping options to reduce infiltration and prevent leachate generation would be considered. Following completion of mining, surface facilities would be removed and contaminated materials would be placed in appropriate facilities. All raises would be sealed with reinforced concrete.

The panel concludes that an adequate conceptual decommissioning plan for the Eagle Point mine has been provided; however, this plan needs to be integrated into a comprehensive decommissioning plan for the Rabbit Lake site.

A-zone and D-zone

Cameco's preferred option for decommissioning the A-zone and D-zone pits is to follow the same strategy as for decommissioning the B-zone pit: i.e., place special waste in the bottom of the mined-out pit and cover it, pump water into the pit, and, once adequate water quality develops in the pit, breach the dykes that isolate it from Collins Bay. The B-zone pit has been flooded for about one year. Preliminary monitoring results indicate that levels of nickel, arsenic and radium are elevated, although this may be related to high levels of suspended solids. Modelling results presented by the proponent suggest that levels of arsenic, nickel and uranium in the B-zone pit will exceed Saskatchewan Surface Water Quality Objectives both in the short and long term. This information was used by the Saskatchewan Environmental Society to support its position that mining of the A-zone and D-zone orebodies is unacceptable; by Environment Canada, to suggest that the pits be filled with waste rock; and by Fisheries and Oceans, to recommend that the dykes between the pits and Collins Bay not be breached. In response, Cameco indicated that there are a number of options to improve the water quality of the pit if monitoring continues to indicate that the quality is unacceptable. These options include adding a flocculant to settle the suspended solids; spraying the pit with ferric sulphate to reduce arsenic concentrations; and promoting the growth of algae that are known to remove contaminants. The AECB advised the panel that it still had major concerns about the decommissioning of the proposed A-zone and D-zone mines.

Modelling results provided by the proponent indicate that the B-zone waste-rock pile is a potential source of contamination of the B-zone pit. This aspect of the development is of interest to the panel since Cameco proposes to place waste rock from the A-zone and D-zone on the B-zone waste-rock pile, which would increase the size of the pile by 17%. Cameco's preferred decommissioning plan for the B-zone waste-rock pile is to grade and vegetate it; however, Cameco indicated that, if modelling predicted an unacceptable impact on water quality of the B-zone pit, it would examine cover options to reduce infiltration and leachate generation.

Another issue related to waste rock is the possibility of acid generation. Oxidation of sulphides in exposed ore can result in the generation of acid, which leaches radionuclides and heavy metals from the rock. The proponent's consultant on this matter advised the panel that waste rock would be classified according to acid-generation potential and that oxidation of sulphide-rich rock would be controlled either by keeping the rock under water or by covering it.

A number of alternative proposals for decommissioning the B-zone waste-rock pile were presented. Environment Canada proposed that Cameco reduce the size of the waste-rock pile by using the rock to cap tailings and special waste and to fill open pits that would be otherwise flooded. Further, it recommended the use of extensive groundwater and hydrological contaminant modelling to determine the most appropriate cover option for the B-zone waste-rock pile. The Saskatchewan Environmental Society proposed two options for the B-zone waste-rock pile. One option is to place as much of the waste rock as possible in the Rabbit Lake tailings pit and provide a complex cover for the remainder of the rock. The other option is to leave the waste-rock pile intact and provide a complex cover. The complex cover proposed by the Saskatchewan Environmental Society would consist of several layers designed to reduce erosion and prevent infiltration. The AECB made it clear that approval for final decommissioning or abandonment of the B-zone pit area, including the waste-rock pile, had not been given.

The panel concludes that there is insufficient information to determine whether the A-zone and D-zone pits and waste rock generated from these pits can be successfully decommissioned. The information required would come from analysis of waste-rock management options, experience in decommissioning the B-zone pit and from detailed modelling.

9. **The panel recommends that mining of A-zone and D-zone not proceed until the proponent has demonstrated that the B-zone pit and waste-rock pile can be decommissioned without significant adverse environmental impacts and that detailed plans for decommissioning of A-zone and D-zone pits and waste rock have been prepared and approved. The proponent should demonstrate that these plans meet the ALARA principle.**

Rabbit Lake Tailings Pit

Cameco's proposal for closure of the Rabbit Lake tailings pit is to place 1.5 m of sand on top of the tailings. After placement of the cover, groundwater levels would be allowed to return to normal and Rabbit Lake would be restored. Predictions of water quality in the restored Rabbit Lake have been made, although these do not consider the contribution of Rabbit Lake waste rock placed near the pit. Environment Canada stated that further assessment of cover options is required and advocated the use of a waste-rock cover. The AECB advised the panel that the information presented on the Rabbit Lake tailings disposal facility was adequate to fulfil its requirements for a conceptual decommissioning plan.

The panel concludes that viable options for decommissioning of the Rabbit Lake pit have been proposed. Collection of additional information on the pit and detailed modelling would be required for the development of a final decommissioning plan.

Comprehensive Decommissioning Plan

The foregoing discussion has addressed a number of specific issues related to decommissioning of the Eagle Point, A-zone and D-zone mines, the B-zone waste-rock pile, and the Rabbit Lake tailings pit. Since these components are located on the Harrison Peninsula, which is surrounded by Wollaston Lake, any environmental effects resulting from decommissioning of the Rabbit Lake project could affect adjacent areas of the lake, including Collins Bay, Ivison Bay and Pow Bay. The proponent presented modelling results to indicate that these impacts would be minimal. However, the panel was advised that the models used to predict contaminant generation and movement were based, to a large extent, on assumed values and that these models had not been validated by field measurements. Ultimately, the panel concludes, an overall comprehensive site decommissioning plan would be required.

10. The panel recommends that Cameco initiate the studies required to develop a comprehensive decommissioning plan. In the panel's view, some of the essential elements in this plan are the following:

- a) the evaluation of existing water-quality standards to determine whether these represent adequate targets for decommissioning or whether site-specific standards are required;
- b) the development and validation of models to evaluate the environmental effects of various decommissioning options and the development of a decommissioning strategy that meets established targets;
- c) the establishment of baseline conditions and determination of the nature and extent of a post-decommissioning monitoring program that will be used to evaluate the environmental effects of decommissioning activities; and
- d) an estimate of the time frame and financial resources required to complete the decommissioning program.

The panel has recommended that the Environment Management Committee play an active role in the review and approval of a comprehensive decommissioning plan for the Rabbit Lake site.

3.4 Water Use

On several occasions during the review process, the panel asked the proponent to provide information on water use at the Rabbit Lake operation. The purpose of this question was to obtain a clear understanding of water volumes and contaminant loads from various aspects of the operation, since these ultimately affect contaminant loading to Hidden Bay.

Depending on the phase of the operation and the season, significant quantities of water requiring treatment would come from the Eagle Point mine and, if approved, A-zone and D-zone pits, Rabbit Lake tailings pit, Rabbit Lake mill and surface runoff. In addition, the mill would require between 13.5 and 24.4 litres/sec. (L/s) of freshwater from Collins Bay.

In response to a question from the panel, Cameco identified four opportunities to reduce water usage in the mill and, hence, discharge to the environment.

1. Add a clarifier to the mill effluent-treatment circuit to produce water of suitable quality for seal water and other mill make-up uses.
2. Aerate water pumped from the tailings pit to reduce radon, thus making the water suitable for use in the mill as seal water.
3. Replace wood-stave tanks to eliminate the need to spray them with water.
4. Use boiler condensate for seal water.

Cameco also indicated that in the spring a large amount of snow melt and runoff is collected from secondary containment facilities around pipelines and ore pads. All this water is treated before it is released to the environment, even though contaminant levels are likely low. Cameco is examining ways to minimize the amount of surface water being collected and treated while maintaining the integrity of the secondary containment system.

Environment Canada made a number of recommendations to reduce the volume of contaminated water produced. It suggested that Cameco investigate the use of dewatering wells to reduce groundwater inflows to the Eagle Point mine. Further, it proposed that uncontaminated groundwater flows to the Rabbit Lake tailings pit be collected separately, thus reducing the amount of water pumped from the pit. In addition, it identified a number of possible improvements to the treatment system that could reduce contaminant loading.

11. The panel recommends that Cameco investigate means to reduce the amount of water that requires treatment and the amount of freshwater used. These reductions would decrease contaminant loading to Hidden Bay and thus achieve the goal of the ALARA principle with respect to potential impacts on the biophysical environment. Investigation of water use at the Rabbit Lake operation should include the following:

- a) the consideration of improved milling and water-treatment processes that would result in lower contaminant loadings;
- b) an investigation of ways to use uncontaminated mine-site runoff and mine water in the mill to reduce freshwater consumption;
- c) the reassessment of groundwater inflows to the Eagle Point mine and, if approved, A-zone and D-zone mines to identify options for further reducing volumes of contaminated mine waters; and

- d) **the examination of alternative methods of placing tailings in the pit and operation of the facility to reduce the amount of contaminated water pumped from the facility.**

3.5 Safety of Eagle Point Mine

A number of participants expressed concerns about the safety of mining under Wollaston Lake. Northern communities in particular were concerned that if the mine were to collapse and become flooded it would be a significant source of contamination to the lake.

The panel received a presentation from the proponent's rock mechanics consultant and additional information in Cameco's Addendum. The mine is designed with a 50-m thick undisturbed rock mass, termed a crown pillar, between the top of the mine and the lake. Mining will not be permitted in the crown pillar. The size of the pillar has been based on geotechnical models and experience with other mines located under water bodies. The panel was also advised that a number of instruments had been installed in the crown pillar to

detect any movement of the rock mass. In addition, the crown pillar is typically checked at the beginning of and during each shift.

Cameco's Addendum addressed the potential impact on Wollaston Lake of flooding the Eagle Point mine. Cameco indicated that once the mine was flooded there would be very little driving force to cause an exchange of water with Collins Bay, and that the volume of the underground mine in relation to the total volume of Wollaston Lake would be very low, further reducing the potential for contamination.

The panel concludes that the risks of a collapse of the Eagle Point mine, and potential contamination of Wollaston Lake, are minimal and that an adequate program to manage these risks is in place.

- 12. The panel recommends that results of the crown-pillar monitoring program and any significant changes in the design of the pillar be provided to the Environmental Management Committee.**

4 ENVIRONMENTAL ISSUES

The effect of the proposed development at Rabbit Lake on the biophysical environment is a significant issue in this review. Contamination of the environment by radionuclides and heavy metals is of primary concern. Effluent discharged into Hidden Bay is the most obvious source of contamination; however, other potential contaminant sources include the A-zone and D-zone pits, waste-rock piles, and the Rabbit Lake tailings pit. Contaminants from these sources could find their way into the surrounding aquatic environment, including Collins Bay, Pow Bay and Ivison Bay (Figure 2).

Based on current and predicted performance of the operation, the panel concludes that impacts of full-production mining at Eagle Point on the biophysical environment are either insignificant or mitigable. However, a comprehensive baseline study and monitoring program is required to confirm that these predictions are correct. The panel has concluded that there is insufficient information to assess the environmental impacts of developing the A-zone and D-zone orebodies.

Monitoring is an essential component of the environmental assessment process. Monitoring programs can determine if actual impacts are as predicted, ascertain whether mitigation programs are effective in reducing impacts, and identify impacts not predicted so that they can be mitigated. Cameco used results of monitoring programs at Rabbit Lake to support its position that the environmental effects of the proposed development would be minimal. For these reasons, monitoring programs were the focus of the discussion on environmental issues at the hearings.

4.1 Observations on the Monitoring Program

In its presentation to the panel, Cameco stated that it has monitored the Rabbit Lake operation and the surrounding environment for the past two decades. In 1992, approximately 7,000 samples of air, water, lake sediments, plants and fish were collected. The company estimates that approximately 23 person-years of effort and in excess of \$2 million are dedicated annually to monitoring and surveillance programs.

Cameco's claim that monitoring demonstrates that its Rabbit Lake operations have caused **"very little impact on the local environment"** was the subject of considerable discussion at the hearings. This claim was generally supported in presentations made by the AECB. A number of presenters expressed the view that the industry is well regulated and they were confident that the environmental effects were minimal. However, many other presenters expressed a lack of confidence in the monitoring program and hence disputed the conclusion that impacts were minimal. Some raised specific issues related to the design of the program. For example, the Saskatchewan Environmental Society questioned the location of sampling stations in Hidden Bay. Others had more general concerns about the program that could be characterized as a lack of confidence in the regulatory agencies. In the Athabasca region, the lack of community involvement in the monitoring program was often mentioned. Despite efforts by Cameco to inform northern residents about the project and its

effects, the current monitoring program appears to provide little assurance to those who could be most directly affected by the project. Although the monitoring program may have met the requirements of regulatory agencies, it is clear that the program has neither satisfied public concerns nor gained public trust.

The quality of the monitoring data is of particular concern. Based on the data presented to the panel, there appears to be a lack of quality control in at least some aspects of the monitoring program. For instance, analytical procedures for radionuclides and trace elements in fish tissues were changed in 1982, 1984 and 1986, and the data from 1989 and 1990 were discarded because of problems with the analyses. As a result, there are few comparable data from a decade of sampling for a factor of utmost importance to northern residents who consume fish from Wollaston Lake. Another example of lack of rigor in monitoring is the fact that many of the vegetation plots established in 1979 could not be found in 1986, making comparison over a broad range of vegetation types almost impossible. The panel concludes that the collection and analysis of biological samples did not meet professional standards. These examples inspire little confidence in the ability of the company or the regulatory agencies to adequately manage a monitoring program.

A key component of any monitoring program is a high quality baseline study. Baseline data should be of adequate quality to serve as a basis for statistical and scientific comparison with subsequent data sets taken during and after development of the project. The goal is to draw fact-based, objective conclusions about impacts based on well-defined and repeatable methods. In addition, properly conducted baseline studies provide the basis for impact prediction and development of mitigation programs. The panel concludes that the baseline for the Rabbit Lake operation is inadequate.

The quality of a monitoring program should be judged on the basis of how well it provides answers to questions raised during the design of the program. A monitoring program should be a real-world test to see if predictions were correct and a means of early detection of unpredicted problems and impacts. The monitoring program should also provide information to demonstrate to the public that the impacts of the development are not significant. Based on these criteria, the Rabbit Lake monitoring program must be judged as inadequate.

In summary, the panel concludes that the baseline data and monitoring program are deficient from both a scientific and a public perspective. Poor quality can result from either poor planning or poor workmanship. Better planning of baseline studies and monitoring programs and the application of modern standards, concepts and techniques are necessary to improve the quality of the data.

4.2 Responsibility for Monitoring

Requirements for monitoring are specified in licences issued by the AECB and Saskatchewan Environment and Resource

Management. These requirements are reviewed annually at a meeting between the company and the regulatory Joint Review Group. Changes to the monitoring program are made, as appropriate, and are agreed to by all parties. Sampling is done largely by the company, although the regulatory agencies take spot samples to check the accuracy of the company's sampling and analysis program. The fact that most of the sampling and analysis was done by the company was of concern to some presenters. The panel was told that monitoring programs are directed primarily at compliance with licence requirements, but they are also designed to consider effects on the environment.

A number of alternative ways to conduct the monitoring program were presented. For example, the community of Wollaston Lake specifically requested that the company provide funds for the community to establish its own monitoring program. The Environmental Monitors of the Athabasca Region proposed to establish a group that would monitor uranium mining development in the Athabasca region and provide results of the monitoring program directly to northern communities. An independent citizens' environmental group, composed of representatives from northern band councils and community-based organizations, environmental organizations and universities, was recommended by the Saskatchewan Environmental Society. This group would review monitoring results to determine whether licence conditions were being met and would oversee the development and implementation of decommissioning plans. The AECB provided the panel with examples of community monitoring committees in Ontario. The role of these committees is to review data on the receiving environment and to inform the regulators about community opinions and concerns. The AECB indicated that it would be willing to provide advice to stakeholders in northern Saskatchewan interested in establishing a similar program.

In 1990, Cameco established the Northern Community Liaison Committee. This committee provides a forum for dialogue between the corporation and elected northern leaders on issues of concern, including environmental matters. The company also noted that one of the four environmental technicians at Rabbit Lake is a resident of the Athabasca region. While the panel supports these initiatives, it concludes that they do not go far enough in providing assurance to northern communities. The panel notes with interest the closing statement from Cameco that *"we agree that monitoring of the sites by northern residents is one of the best ways to build trust and confidence in the monitoring program and its results."*

The panel concludes that the public, particularly northern residents, wants a say in the design and implementation of the monitoring program for the Rabbit Lake operation. The panel has previously recommended that establishment of an Environmental Management Committee is essential to provide this input.

13. **The panel recommends that, to rectify the inadequacies in the baseline and monitoring data, the Environmental Management Committee undertake a complete review of the current monitoring program and recommend changes to meet community, scientific and regulatory requirements.**

Issues that should be considered during such a review include the need for an ecological approach, baseline studies, a quality assurance/quality control program, environmental effects monitoring, pathways analyses, research programs and a study of cumulative effects. Specific requirements are detailed below.

The panel is of the opinion that most of the funding requirements for a revised monitoring program could be met by real-locating the 23 person-years and more than \$2 million that Cameco spends annually. Further, the panel notes the proponent's comment that there is some duplication in federal and provincial regulatory requirements which results in increased costs to the company. Elimination of this duplication might provide an additional source of funds for monitoring.

4.3 Baseline Studies

A baseline study is a tool for making before and after comparisons to determine if development has caused changes in the environment. Baseline data ideally should be collected prior to construction of any project. It is not possible to provide a true baseline for the Rabbit Lake operation because mining has been conducted at the site for a number of years. It is, however, possible to provide a baseline for the mining of the Eagle Point, A-zone and D-zone orebodies.

14. **The panel recommends that Cameco undertake a comprehensive baseline study that can be used to monitor and assess the effects of additional development at the Rabbit Lake site. The baseline study should meet the requirements developed by the Environmental Management Committee.**

The panel has recommended that the Environmental Management Committee be the forum in which baseline study requirements are developed. In developing an operational definition of a baseline for Rabbit Lake, the committee needs to specify in detail how and why samples will be collected and analyzed; indicate how data from the baseline will be used in the future to draw conclusions about impacts; and to justify and outline the details of sampling, statistical and other methods that will be used to make pre- and post-development comparisons.

A comprehensive baseline study should consider the following elements.

- The location of the baseline study areas should be examined. Clearly, the baseline study should focus on Hidden Bay, since this is where the effluent from the operation is discharged. Hidden Bay also has the advantage of being relatively small and, therefore, manageable from a sampling and analysis perspective. Consideration should also be given to gathering baseline data on conditions in other bays adjacent to the Rabbit Lake operation (e.g., Collins Bay, Ivison Bay), and on the terrestrial environment.
- The baseline in Hidden Bay should ideally include all species of insects, crustaceans, molluscs, fish, plankton and plants. It could also include microinvertebrates and bacteria, since these are often active members of ecological systems and may be involved in the pathways of metals and radionuclides, especially in the sediments.

- The need for surveys of rare species and evaluation of valued ecosystem components should be determined.
- Scientific quality control should be maintained by taking replicate samples, hiring only qualified taxonomists and field workers, and retaining voucher specimens and samples. Samples, data, and information on the methods used should be available to the public so that independent groups can undertake duplicate sampling or analysis if they so desire.
- The baseline study should consider an analysis of ecological interrelationships, for example, population densities, food chains, species diversity, energy flow and nutrient cycling.
- In addition to the biota, physical parameters, such as seasonal cycles in the limnology of Hidden Bay, need to be measured. The pH, oxygen profile, and thermal stratification, as well as the physical conditions in the sediments where the benthos dwell, could be included in the baseline.
- Existing data on concentrations of heavy metals and radionuclides in biota, water and sediments should be reviewed to determine if these are adequate.
- Reviews of the scientific literature on toxicity and bioaccumulation could be incorporated into information gathered from the field work.

4.4 Monitoring

The primary purpose of the baseline survey would be to provide an understanding of the structure and function of biota in Hidden Bay and the components of the physical environment that affect these organisms. The baseline survey in Hidden Bay would identify key biotic and abiotic components that should be incorporated into the revised monitoring program and in the baseline for other areas of the site. Selection of key biotic components could be based on such factors as abundance, function in the food chain, sensitivity to heavy metals and radionuclides, and use by humans.

As noted above, the panel has recommended that the Environmental Management Committee review the existing monitoring program and provide recommendations for change. In addition, the committee should consult with the scientific community and review the literature when determining monitoring requirements. During the public hearings, it became apparent that the purpose and objective of a monitoring program were viewed differently by a number of presenters. The main views are outlined below.

The AECB indicated that **compliance** monitoring is required to check that effluents from the mine do not exceed prescribed limits. This approach primarily involves monitoring physical and chemical attributes of the effluent and the receiving environment. While this is necessary from a regulatory viewpoint, it represents an incomplete view of the environment and neither considers factors such as total loading to the environment over the course of the development nor does it incorporate the concept of cumulative impacts.

Another approach is to identify and monitor **valued ecosystem components**, i.e., attributes of the environment for which there is a public or professional concern. Valued ecosystem components can be determined on the basis of social, cultural, economic, ecological or aesthetic values. In the case of this project, valued ecosystem components might include human food organisms (fish and caribou) and furbearers, which are important to the aboriginal way of life. Although this approach goes beyond compliance monitoring, in that biota rather than physical and chemical parameters are monitored, it does not lead to a complete understanding of the system.

A third approach, which stimulated considerable discussion at the hearings, was that of **pathways analysis**. This approach uses field studies and computer models to examine the movement of contaminants through the food chain. Pathways analyses were used by both the proponent and the AECB to demonstrate that the radiological impact of the additional development at Rabbit Lake would be acceptable. The panel was provided with information on field studies of lead and polonium pathways in lichens, caribou and wolves that shows the practicality and value of this approach. Environment Canada recommended that the proponent conduct radionuclide pathway analyses for local aquatic and terrestrial food chains in addition to the analyses for regional food chains already performed. The results of the pathway analyses could be used to identify areas where environmental monitoring is required.

The panel concludes that there is a need for compliance monitoring to ensure that regulatory standards are being met, for monitoring of valued ecosystem components to ensure that critical food items for local communities are not contaminated, and for pathways analysis based on field data to provide a greater understanding of the fate of heavy metals and contaminants discharged to the environment. The panel believes that a well-planned and integrated monitoring program can achieve all these objectives. As previously recommended, the Environmental Management Committee is the appropriate forum to develop this program.

15. **The panel recommends that Cameco implement a detailed monitoring program that meets the requirements developed by the Environmental Management Committee.**

The panel proposes that the monitoring program initially focus on Hidden Bay for the same reasons discussed in the section on baseline studies. Depending on the results of the monitoring program in Hidden Bay, the program may need to be expanded to include other areas around the operation. The monitoring program in conjunction with a baseline study should:

- determine how the Hidden Bay ecosystem functions and identify important parameters and interrelationships;
- identify the fate of contaminants discharged to the aquatic environment and examine the effects of these discharges on the aquatic biota;
- evaluate the effectiveness of current regulations and guidelines in protecting the aquatic environment;

- examine and determine the effects of loading on the aquatic environment;
- determine the need for site-specific water quality criteria to evaluate environmental impacts in Hidden Bay; and
- determine the need for other site-specific or regional monitoring programs based on the results obtained from Hidden Bay.

4.5 Research Requirements

The panel recognizes that there are a number of areas where additional research is required to improve understanding of the effects of uranium mining and milling on the environment. A comprehensive monitoring program in Hidden Bay could provide some of this information. Further, the monitoring program might provide the platform on which government and universities could build other, more specific, research programs.

16. **The panel recommends that the Environmental Management Committee identify research needs and establish communication with those (e.g., universities, research institutes) that have the resources and abilities to conduct the research.**

In general, research could be carried out on basic taxonomy, food webs and food chains, community and population structure, interactions among the biotic community, radionuclides and heavy metals, and the dynamics of the physical environment in relation to organisms and hazardous materials.

4.6 Cumulative Impacts

The Rabbit Lake panel was instructed to assess the cumulative impacts of the existing operation and the proposed development of the Eagle Point, A-zone and D-zone mines. Many

presenters addressed the broader issue of the cumulative effects of the Rabbit Lake development and other uranium mines proposed or operating in northern Saskatchewan. This broader issue is beyond the panel's mandate but is being addressed by the Federal/Provincial Panel on Uranium Mining Development in Northern Saskatchewan.

Cameco discussed the cumulative effects of additional mining at Rabbit Lake in its EIS Addendum. The proponent concluded that during the operational phase the cumulative impact of mining Eagle Point, A-zone and D-zone would be minor. However, following decommissioning of A-zone and D-zone and flooding of the pits, there may be an impact on Collins Bay. Additional studies on the A-zone and D-zone proposal are required to address this issue.

The panel concludes that the cumulative effects of mining the Eagle Point orebody are likely to be either insignificant or mitigable, whereas those associated with mining the A-zone and D-zone orebodies are unknown. Comprehensive studies and monitoring programs are required to verify that these predictions are correct. Additional information on the cumulative effects of mining at the Rabbit Lake operation will come from engineering studies associated with mine development and decommissioning and from environmental monitoring programs. It is important that these programs be coordinated and their results assessed comprehensively to maximize understanding of cumulative impacts.

17. **The panel recommends that the Environmental Management Committee provide input into the design of engineering and monitoring programs and evaluate the results of these programs to identify any cumulative effects of additional development at Rabbit Lake and to recommend ways to address any impacts identified.**

5 SOCIOECONOMIC ISSUES

The panel's terms of reference include a review of the impact of employment and socioeconomic opportunities afforded northern residents by the proponent and the measures necessary to implement those opportunities.

In conducting its review, the panel considered the impacts of the proposal on individuals, their families and communities, traditional Dené values and lifestyles, and the Athabasca region generally. Specific issues addressed below are whether area residents obtain their share of the jobs and other benefits that the new mining operation would generate; whether fair compensation is given for disruptions to trapping and other traditional lifestyles; the quality of working life; and whether area residents are adequately informed about the Rabbit Lake operation.

5.1 Employment

Cameco has indicated that the proposal is likely to increase full-time employment at the Rabbit Lake site during the 11-year life of the project by about 5% over the current level of 320 workers.

In numerical terms, this modest impact would appear to offer few opportunities for residents of the Athabasca region. The proponent remains committed to increasing the percentage of northerners in its workforce to 50% by 1995 (a northerner is defined by Saskatchewan as someone who has lived in northern Saskatchewan for 10 years or one half of his or her life). Cameco's efforts to date – raising the northern workforce participation from 25% in 1988 to 43% at present – suggest that the corporation is determined to reach this goal.

The limited number of jobs that would be created suggests that this goal can only be realized through a sustained effort by the proponent. For example, even if northerners obtained all the new positions, participation would not reach 50%. This target may be more achievable if the proponent places northerners in vacant positions created by turnover, even though the levels of turnover have been low in recent years.

A number of presenters stated that Cameco should ensure that Athabasca Basin aboriginal people are given the first chance to fill new and vacant positions. The logic supporting this position is that, since these people are the most directly affected by the mining operation, they should be entitled to most of the jobs that become available. In response, Cameco stated that residents of the Athabasca Basin receive first priority in hiring for any position at Rabbit Lake.

The proponent acknowledged that the Wollaston Lake community has not received its share of the jobs at Rabbit Lake. Cameco indicated that it may be possible to rectify this by increasing the number of full-time positions occupied by workers from Wollaston Lake from nine to 16 or 17.

Wollaston Lake representatives proposed that Cameco offset some of the traditional lifestyle opportunities displaced by the Rabbit Lake mine by creating a labour pool of workers from the community. These presenters noted that such a pool

would allow participants to move in and out of the workforce easily. In response to this suggestion, the proponent indicated that the labour pool may be an effective way to utilize a flexible supply of labour that would be nearby and available on short notice.

The panel supports the proponent's pursuit of the 50%-northerner goal and urges Cameco to make every reasonable effort to realize it. The panel believes that Athabasca Basin aboriginal people are entitled to a greater share of the jobs at Rabbit Lake, and it therefore concludes that the proponent should, where possible, offer new and vacant positions to these northerners. In addition, Cameco is encouraged to double the number of full-time workers from Wollaston Lake as one way to redress the imbalance in benefits received by this community. The panel also proposes that the proponent consult with Wollaston Lake representatives to establish a labour pool from that community.

5.2 Other Economic Benefits to Athabasca Basin Communities

The proponent spends about \$100 million a year on goods and services in support of its overall northern mining operations, and it estimates that the proposed Rabbit Lake operation would generate about \$40 million worth of business annually. Twenty percent of Cameco's purchases are from enterprises in northern Saskatchewan, primarily in the La Ronge area.

Residents of the Athabasca Basin believe that they do not receive a fair portion of this business, and the proponent conceded that the Wollaston Lake community has benefited even less than other Athabasca Basin communities. This situation can be explained, in part, by three features of the basin: its weak transportation infrastructure; its underdeveloped mining-support sector; and its scarcity of venture enterprises.

Presenters suggested a number of ways to encourage the proponent to direct more business to communities in the Athabasca Basin. For example, the Hatchet Lake Band stated that the proponent should be required to identify one service-type function which could be delivered by a contractor from Wollaston Lake. A particularly promising proposal features joint ventures. Joint ventures between Athabasca Basin enterprises and other Saskatchewan firms to supply goods and services to the Rabbit Lake operation would increase the level of benefits in the area and support the development of local entrepreneurs. Such ventures could strengthen the local economies if they focused on activities compatible with traditional lifestyles.

The interest in joint ventures expressed by Basin communities and Cameco's willingness to consider practical contract proposals indicate that such partnerships should be cultivated. Leadership by Cameco and advice from groups that have already established joint ventures, such as the Prince Albert Tribal Council, would enhance the viability of these ventures.

The panel concludes that either joint ventures or direct contracts with Athabasca Basin communities offer viable means to augment the economic benefits to these communities. Clear leadership by Cameco in this area is desirable, and the panel suggests that the proponent consider establishing specific corporate goals to increase the flow of benefits to these communities, especially Wollaston Lake. The panel believes that groups such as the Prince Albert Tribal Council could support the creation of joint ventures by providing advice to the communities involved and by working with Cameco and specific entrepreneurs to implement agreements.

5.3 Trapper Compensation

The First Nation communities from the Athabasca Basin have a unique relationship to the land and water in the area and have traditionally derived their livelihood from them. It is important to note that the Dené in the area tend to value trapping more for the lifestyle it supports than the cash it generates.

The proponent admits that the Rabbit Lake operation has affected the people's ability to use the land adjacent to the mine site, particularly in Block N26. In fact, Cameco recently renegotiated an agreement with a local trapper to compensate him for the adverse effects on his way of life caused by the activities at Eagle Point. The company is also considering the claim of another trapper. The Hatchet Lake Band expressed concern about the level of compensation provided to trappers and proposed that minimum guidelines be established. Cameco stated that it would rather deal with trappers' compensation on a more comprehensive basis than address individual claims as they arise.

This issue raises questions about what is reasonable compensation for the resulting damages. Such claims could be dealt with on a case-by-case basis or within the context of a more comprehensive framework that enunciates the basic principles involved, including the method of resolving disagreements. The panel believes that the latter approach would help the parties better understand what to expect and would ensure that individual claims are addressed consistently and equitably.

The panel concludes that the proponent should consult with representatives of Wollaston Lake and the Prince Albert Tribal Council to develop a framework for trapper compensation. It is desirable that Dené people, especially elders, participate directly in creating this framework.

5.4 Quality of Working Life

The quality of working life includes a safe and healthy workplace, adequate training for individuals to enable them to gain employment and to progress into technical and managerial positions, and work schedules that allow employees to reconcile their paid employment with their family and community activities. This broader concept of work is consistent with the Dené tendency to perceive events in holistic terms. Worker health and safety is addressed in Section 6.2; the other issues are considered below.

5.4.1 Training

Dené in the Athabasca Basin expressed considerable concern that their access to certain jobs at Rabbit Lake was limited because they lacked the formal education to qualify for them. This is a serious issue, since Saskatchewan Education estimates that the majority of residents of working age in the Athabasca Basin have less than grade 9 education.

A number of aboriginal presenters questioned whether low levels of schooling should preclude them from technical positions with Cameco. They pointed out that in the past they had worked in uranium mining even though they did not have the academic credentials. The proponent indicated that it hires many people with less than grade 10 education. Cameco does not require a specific minimum level of education to work at the Rabbit Lake operation, but rather establishes the level to meet the requirements of a specific job. Approximately 50% of the positions at Rabbit Lake now require some sort of post-secondary education or training. These positions are primarily in the trades and in the technical and scientific areas.

The panel encourages the proponent to review its educational standards for technical positions to determine if on-the-job training is a viable alternative to these standards. Cameco may find it advisable to consult with the appropriate government agencies where these standards are based on provincial norms.

Cameco has demonstrated a commitment to provide on-the-job apprenticeship training at Rabbit Lake for aboriginal people from the Athabasca Basin as well as for other northerners. This training gives aboriginal people access to more responsible technical positions at the mine and provides them with transferable skills.

Several aboriginal northerners working in uranium mining expressed the desire to become supervisors or managers with Cameco. The proponent has displayed sensitivity to these aspirations. The informative presentation by the aboriginal northerner employed by the company as a personnel assistant illustrated that Cameco is making progress in this area.

The panel commends the proponent for its on-the-job apprenticeship training program and encourages Cameco to maintain and, if possible, intensify its activities to prepare aboriginal northerners for managerial positions.

Cross-cultural training is an effective way to facilitate participation by aboriginal northern workers in the Rabbit Lake operation. Cameco has indicated that there was mandatory cross-cultural training at Key Lake during its initial stages. The proponent stated that the need for such training diminished as the number of aboriginal workers from northern Saskatchewan increased and they became integrated into the mining environment.

The panel suggests that Cameco assess its current and ongoing need for cross-cultural training for aboriginal and non-aboriginal employees at the Rabbit Lake site. The proponent is encouraged to involve workers and their community representatives in this assessment.

5.4.2 Work Schedules

The proponent has indicated that the seven-day in/seven-day out work schedule contributes to efficient mining operations and allows aboriginal workers to maintain their traditional lifestyles in northern communities. Cameco reported that it recognizes the special needs of these workers and attempts to accommodate them in scheduling vacation leave. The proponent acknowledges that the frequent partings and reunions caused by this work schedule can be stressful on family members. Cameco also stated that it is considering supporting an independent research project on the work schedule with a graduate student at the University of Saskatchewan.

Several presenters expressed support for the work schedule, and no significant concerns were voiced about it during the public hearings.

In the absence of clear evidence to the contrary, the panel believes that the work schedule is functioning relatively well. The proponent is encouraged to support the research project designed to provide more systematic information about the schedule. Given the interest and insights that workers, their families, and Athabasca Basin communities have on this subject, it is suggested that these groups participate in the study.

5.5 Proponent-Community Relations

Presentations to the panel by members of Athabasca Basin communities, particularly Wollaston Lake, revealed that there is room to enhance relations between Cameco and these

communities. Indeed, a number of conclusions and recommendations in this report are at least partly intended to increase dialogue and cooperation between the proponent and the communities.

Aboriginal northerners participating in the public hearings identified a need for better communications between Cameco and these communities about employment and business opportunities and about mining operations. The panel recognizes that the proponent has a northern office in La Ronge to serve this function; however, its geographic remoteness from the communities probably erodes its effectiveness. One way to enhance communication may be for Cameco to appoint a resident from the Athabasca Basin to its Board of Directors. The panel notes that Cameco has undertaken other initiatives, such as the recently formed committee of Cameco officials and Athabasca Basin community representatives, to improve communications with local residents. Despite these steps forward, there are still clear signs of continued misunderstandings between the proponent and Wollaston Lake residents in particular. Left to fester, these communications breakdowns could fuel greater mistrust and tension between the parties.

The panel supports Cameco's recent efforts to communicate more effectively with Athabasca Basin communities. The panel suggests that the proponent consider additional means to communicate with these communities, such as arranging for the Prince Albert Tribal Council to disseminate information on the Rabbit Lake operation. In light of the unique relationship between Cameco and the Wollaston Lake community, the panel believes that these parties should engage in direct dialogue on issues of specific concern to them.

6 HEALTH AND SAFETY ISSUES

The panel's consideration of health and safety issues included both community health and worker health and safety. Community health addresses the definition of health, northern community concerns and radiation risks to those communities. The main issues pertaining to worker health and safety were the proponent's programs in this area, radiation risks and effects of radiation exposure.

6.1 Community Health

6.1.1 Definition of Health

The panel's technical specialists on social health issues, Moore Chamberlin and Associates, provided many useful insights, which are included throughout this section. In their 1992 report to the panel, at pages 58 and 59, Moore Chamberlin proposed that the following common values or assumptions be used when evaluating the EIS.

- ***Health is defined holistically as involving the mental, physical, emotional and spiritual aspects of the individual and community. As defined by the World Health Organization, 'health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'.***
- ***Equal weight must be given to the impacts of uranium mining on the people who are permanent northern residents as to all other beneficiaries. They must be seen as rightful and equal partners with any outside institutions who wish to use the region for their own purposes. Northern residents must receive direct benefit from industry operating in their region.***
- ***As rightful equal partners, the values and culture of the partners must be respected. Inherent contradictions exist between native cultural values and industrial values. Considerable anxiety is associated with the change from a traditional land base to industrialization. This has resulted in anxiety and fear due to an increased perception of risk. This increases the negative impacts attributed to development. Activities and industry coming into the North need to make efforts to improve knowledge, build self-reliance, reduce dependency and thereby contribute positively to the health and well-being of permanent residents of the region.***
- ***A community development approach is currently being utilized for health planning and development in various northern locations. This approach views participation, involvement and empowerment of community members in addressing issues that affect their community as being critical to optimizing the full individual, social and economic health of the community.***

A number of these views were echoed by the community of Wollaston Lake (Hatchet Lake Band). In a presentation to the panel, a spokesperson for the community said:

We are also disappointed that the proponent has made very little effort to understand and appreciate the concern of this community, and to accommodate those concerns. We must remind Cameco that our concerns are unique.... It may be necessary to require that Cameco deal directly with Wollaston as a condition of its operating agreement.

(Jack Bell, Wollaston Lake, July 5, 1993)

The panel concludes that these views reflect a profound concern that many northern residents share with regards to this development.

6.1.2 Northern Community Concerns

The perception of risk can have a negative impact on the health of communities. Northern community concerns include damage to the land, contamination of the aquatic environment, and changes in the distribution and abundance of fish and wildlife. These issues have been addressed to a large extent in the EIS and supporting documents; however, these reports have done little to reassure communities that feel they have been misled and betrayed by governments, outsiders and private companies in the past. The panel has recommended the establishment of an Environmental Management Committee to provide a mechanism for community involvement. The panel believes that direct involvement of northern communities in monitoring and their input into decisions regarding the development of the Rabbit Lake operation would do much to alleviate their concerns about damage to the environment.

In summary, the people of the North do not feel that the proponent has an appreciation for the value of their land. The panel concludes that the Environmental Management Committee should work with Cameco to investigate ways in which this perception might be mitigated, including community input to monitoring of the operation and the use of traditional ecological knowledge in monitoring programs.

The people of the North need to know they are not going to become ill from eating fish. The communities sought guarantees that the proposed mining would not adversely effect the health of the fish population, the health of humans who eat the fish, or the marketability of fish.

The Department of Fisheries and Oceans, in reviewing the documentation provided to the panel, presented the following information: any activity that results in members of the public receiving a radiation dose of more than 1 millisievert/year (mSv/year) should be avoided or altered. The panel was told that one person would have to consume at least 300 kg of fish from Beaverlodge Lake to receive a dose of 1 mSv. Since radiation levels in Wollaston Lake are lower than in Beaverlodge Lake, even more fish would have to be consumed to reach the same dose. Thus, it is unlikely that eating

fish from Wollaston Lake would lead to doses of 1 mSv/year among members of the public.

6.1.3 Radiation Risks

The effect of radiation on people away from the mine site was raised. In particular, concern was expressed that radon gas would be carried by wind from the mine site, affecting adjacent communities.

The Radiation and Environmental Protection Division of the AEBC provided the panel with information on the magnitude of radiological impact should the proposed development proceed. It was also pointed out that the permissible levels of radiation for the public are generally 5% to 10% of the permissible levels for workers at the mine site. Doses to individuals at Hidden Bay Lodge or in the community of Wollaston Lake were estimated to be well below the regulatory dose limit for the public, both with and without expansion of the mining operation. In the post-decommissioning phase, estimated doses to these reference groups would not significantly differ between the expansion and no-expansion scenarios. Based on these findings, the AEBC considers that the potential radiological impact of the Rabbit Lake development would be acceptable.

Environment Canada also verified that the calculated radiation doses to the communities far-removed from the mines, which would include the Hamlet of Wollaston Lake, would be very low. However, Environment Canada recommended that the proponent conduct radionuclide pathway analyses for local aquatic and terrestrial food chains, not just regional food chains. Further, Environment Canada recommended radiation-dose modelling for humans living year-round on or immediately adjacent to the site.

On the basis of information provided by the proponent, the AEBC and Environment Canada, the panel is satisfied that the radiological impact of the proposed Rabbit Lake development on humans will be acceptable. The panel suggests that, when developing the monitoring program, the Environmental Management Committee consider the need for site-specific pathway analyses based on field data.

Health issues pertaining to the family were not addressed during the hearing. For example, there is no reference to any kind of health program planning that would address the emotional needs of workers and their families and there is no reference to any personal or group counselling service available at the workplace or away from the mine site.

The panel encourages Cameco to consider the health issues of workers' families. Since the panel does not think this topic is the sole responsibility of the proponent, it is proposed that Cameco consult with others involved with health planning for the northern communities in considering family health issues.

6.2 Worker Health and Safety

6.2.1 Health and Safety Programs

Cameco stated that the mine-water spill at Rabbit Lake in 1989 caused it to reconsider its approach to environmental and safety issues. Since the spill, Cameco has implemented a number of measures to promote the health and safety of employees at the Rabbit Lake operation.

- Cameco's Board of Directors appointed an environmental and workers' safety committee, which reviewed company policy and ultimately endorsed a new environmental and workers' safety policy. The policy states that the health and safety of employees, the health and safety of the public, and the protection of the environment are primary concerns and responsibilities. It goes further and demands compliance with both the letter and spirit of the policy, as well as with all related laws, regulations and licence conditions.
- The Rabbit Lake safety department conducts training, performs regular inspections, operates a radiation protection program, monitors industrial hygiene and maintains trained emergency teams to deal with mine accidents, fires, spills and transportation mishaps. There is an occupational health nurse on the site, and most employees have some level of first aid qualification. Medical surveillance starts with a pre-employment medical and continues with annual medical examinations conducted at the site. During the hearings, there was considerable discussion about these issues, and employees and medical personnel verified that these procedures are in place.
- New employees at Rabbit Lake receive basic radiation protection and safety training on arrival at the site. They are subsequently enrolled in a more detailed radiation safety course and receive more specific safety training on the job.
- There are two occupational health and safety committees, one for each shift. These committees consist of an employee and supervisor from each department. The committees meet regularly, conduct safety inspections, participate in accident investigations and accompany regulatory inspections.
- For radiation protection, Cameco must have a Code of Practice approved by the AEBC. The Code of Practice defines a series of action levels and specifies measures to be taken once certain exposure levels are reached: the greater the exposure rate, the more demanding the action required. By following the Code of Practice, actions are taken before individual exposures could accumulate to the point where an exposure limit might be exceeded.

The panel concludes that Cameco has demonstrated a commitment to worker health and safety.

6.2.2 Radiation Risks

According to Cameco, radiation exposures associated with open-pit mining of the A-zone and D-zone should parallel

those of the B-zone operation, which were well below regulatory limits. At Eagle Point, the narrow confines of the underground operation bring the miners into closer contact with the ore and require greater ventilation. The AECB noted that Cameco will be required to submit updated ventilation plans prior to a licensing decision.

The mining methods being tested at Eagle Point, such as non-entry mining techniques and the use of remote-controlled loading equipment, are designed to keep the miners away from radiation sources. In general, work is organized to minimize the time that miners spend close to the face being actively mined. Some exposure is inevitable during placement of the blasting agent, but this can be minimized by good planning and efficient operation.

A potentially significant source of exposure is ore collected at the draw points. Mucking of broken rock is done with scoop trams that can be controlled by an operator away from the face, in low radiation fields. The principal reason for approaching the active face would be to repair equipment that had broken down. In this circumstance, another piece of mobile equipment would be used to haul the broken equipment away from the face for repair in a lower radiation field.

When miners have to enter higher radiation areas, they are issued with direct-reading dosimeters, which can be read on the spot. Thus radiation doses can be checked frequently during repair or retrieval work. Should the rate of dose accumulation be excessive, the work could be terminated before the accumulated dose became unacceptable. The dosimeter readings are monitored not only by the employee, but also by the supervisors, superintendents and by head office staff in Saskatoon.

Radon in water – a potential source of radioactivity in the Eagle Point mine air – was of concern to a number of presenters. The proponent responded by describing its radon-monitoring practice. When large water flows are encountered, the water is sampled and analyzed for radon; where necessary, the water is handled so as to prevent the release of radon into the mine air. Both continuous monitors and grab sampling are used to measure radon progeny in the mine air, yielding the information necessary for proper control of the ventilation system.

6.2.3 Effects of Radiation Exposure

The AECB, in a presentation to the panel, explained that several measures and units are used to quantify radiation exposure. An **absorbed dose**, measured in grays (Gy), is the amount of energy imparted by radiation to a unit mass of matter such as tissue. Equal absorbed doses do not necessarily have equal biological effects: 1 Gy imparted to tissue from subatomic particles (such as alpha particles) is more harmful than 1 Gy from X-rays or gamma rays. To put all types of radiation on an equal basis with regard to their potential for causing harm, the equivalent dose is used. An **equivalent dose**, measured in millisieverts (mSv), is the absorbed dose multiplied by a factor that takes into account the effectiveness of a particular radiation type in causing harm. An **effective**

dose, measured in millisieverts, is the sum of the equivalent doses in each tissue, weighted for the risk associated with that tissue. Thus, this unit broadly indicates the risk to health from any radiation exposure regardless of type and energy of the radiation.

Another unit, **working level (WL)**,¹ is used to quantify the concentration of radon and its decay products in air. In mining environments, exposure to radon progeny is measured by **working level month (WLM)**, that is, the exposure resulting from the inhalation of air containing 1 working level of radon progeny for 1 working month.

Current AECB regulations set the dose limit at 50 mSv/year and set the annual limit for exposure to radon progeny at 4 WLM. These regulations are based, to a large extent, on recommendations of the International Commission on Radiological Protection (ICRP). In 1991, the ICRP published new recommendations on radiation protection. Based on ICRP recommendations, the AECB proposed a reduction in dose limit from 50 mSv/year to 20 mSv/year. These proposed changes to the *Atomic Energy Control Regulations* are outlined in Consultative Document C-122 issued in July 1991 for comment by licensees and the public.

The proponent provided data that demonstrated that the dose levels in Eagle Point were low. In the 12 months ending March 31, 1993, the average gamma radiation dose at Eagle Point was 1.28 mSv and the maximum was 10.2 mSv, 3% and 20%, respectively, of the annual limit of 50 mSv. The average radon progeny exposure was 0.47 WLM and the maximum was 1.48 WLM, 12% and 37%, respectively, of the annual limit of 4 WLM. During production mining, the average effective dose for Eagle Point miners is predicted to be 3.6 mSv, 18% of the proposed new limit of 20 mSv/year averaged over a 5-year period. The most exposed worker would receive 15.8 mSv, 79% of the proposed limit.

The effect on workers involved in milling higher grade ore from A-zone, D-zone and Eagle Point mine was another issue raised during the review. Cameco predicted future exposures to mill workers by extrapolating from current exposure levels. These projections suggest that radiation exposures in the mill would be below the proposed AECB dose limits.

The panel is satisfied that radiation protection is of uppermost importance to Cameco and that it intends to keep the exposure as low as reasonably achievable. As noted above, the AECB has proposed amendments to the *Atomic Energy Control Regulations* that would reduce the dose limit to 20 mSv/year. Information presented by Cameco indicated that it would be able to meet the new standard proposed by the AECB with no major changes to operating plans.

The panel therefore concludes that application of the new standard to the proposed development at Rabbit Lake would be achievable and could result in a greater level of worker protection. It should be noted, however, that exposure levels for some workers would be close to the new limit. Greater vigilance might be necessary to ensure that these workers do not exceed the new standard.

The panel notes that the AECB has called for input from the industry and public on the proposed revisions to the *Atomic Energy Control Regulations*. Comments received will be used to develop the legal wording of the proposed regulations, which will then be published in the *Canada Gazette*. Before the regulations become law, the industry and public will have an opportunity to comment. Although the panel supports the proposed reduction in dose limits, it would appear premature to recommend application of this standard to the Rabbit Lake operation until the regulatory review process is completed. Application of a more restrictive standard to one operation could place it at a competitive disadvantage and may also circumvent the regulatory review process.

- 18. The panel recommends that the AECB complete the consultation process on the regulatory changes proposed in C-122 in a timely manner and make every effort to have the revised regulations in place before full-production mining begins at Eagle Point.**

7 MONITORING, ENFORCEMENT AND COMPLIANCE ISSUES

The terms of reference for this review specifically direct the panel to consider the adequacy of monitoring, enforcement and compliance systems to ensure that the measures necessary for mitigating adverse impacts can be implemented. Monitoring is addressed in detail in "Environmental Issues" (Section 4). Other issues related to this aspect of the mandate are the adequacy of regulations and guidelines; reporting of spills; fish habitat compensation; and financial security for funding decommissioning and remediation of unforeseen environmental impacts.

7.1 Regulations and Guidelines

The federal *Metal Mining Liquid Effluent Regulations* (MMLER) authorize the discharge of effluents from mining operations into waters frequented by fish. These regulations, promulgated in 1977 under the federal *Fisheries Act*, are administered by Environment Canada. The regulations apply to base metal, uranium and iron ore mines, and compliance is mandatory. For uranium mines, the MMLER effluent concentrations are specified in licences issued by the AECB.

The MMLER set national limits for arsenic, copper, lead, nickel, zinc, radium 226, total suspended matter and pH. The limits are based on concentrations that could be achieved with the best practicable technology (BPT) existing when the regulations were developed. In 1984, the regulations were reviewed and the public consulted; however, no changes were made. The panel understands that Environment Canada is again reviewing the regulations with a view to amending them. That review is considering input from a number of stakeholders, including the mining industry and environmental non-governmental organizations.

Data presented by the proponent and the regulatory agencies indicate that effluent discharges from the Rabbit Lake operation meet the MMLER. Mean annual concentrations of regulated parameters were all less than 10% of the limits in 1992. Similar levels of performance have been predicted for the mining and milling of A-zone, D-zone and Eagle Point ore. Notwithstanding, concern was expressed at the hearings that the MMLER do not cover a number of elements in the Rabbit Lake effluent. For example, uranium, mercury and molybdenum are not regulated. Further, the MMLER consider only dissolved radium whereas Saskatchewan regulates total radium; this may provide a better measure of loading to the environment. Moreover, these regulations have not been updated since 1977 and do not reflect either current technology or information on the biological effects of these releases.

19. **The panel recommends that Environment Canada's current review of the MMLER include an examination of the feasibility of regulating all toxic substances in the Rabbit Lake effluent. Further, any revision of the regulations should take into account**

current technology and the biological effects of effluent releases. The panel urges Environment Canada to complete this review and amend the regulations in a timely manner.

It should be noted that, although the panel is recommending revision of the MMLER, it considers that these regulations establish only the minimal conditions for environmental protection. The panel has recommended application of the ALARA principle, examination of total loading to the environment and possible use of water quality guidelines as means to further reduce impacts.

Several presenters suggested that Cameco should meet the *Canadian Water Quality Guidelines* (CWQG) and the *Saskatchewan Surface Water Quality Objectives* (SSWQO) in addition to the MMLER. For example, the Department of Fisheries and Oceans recommended that all effluent discharges entering receiving waters should meet the criteria of the CWQG, which, it contends, provide greater protection to aquatic biota than the SSWQO. Environment Canada proposed that site-specific water quality objectives be developed for Effluent Creek and Hidden Bay based on a combination of the SSWQO, CWQG, baseline water quality conditions and scientific requirements for protecting aquatic ecosystems. The Saskatchewan Environmental Society recommended that Cameco be required to meet the CWQG in its Rabbit Lake operations.

The CWQG, prepared jointly by the federal and provincial governments, set national objectives for Canadian surface waters but have no regulatory status. The CWQG were used to develop the SSWQO, which more specifically reflect conditions in Saskatchewan. Like the Canadian Guidelines, the Saskatchewan Objectives also have no legal status.

Effluent discharge from uranium mines is regulated federally under the MMLER and in Saskatchewan by the *Mineral Industry Environmental Protection Regulations*. The panel notes that information provided by Cameco during the hearings indicates that the mean concentrations of metals and radionuclides measured in 1992 at the mouth of Effluent Creek met both the CWQG for freshwater aquatic life and the SSWQO for protection of aquatic life and wildlife. The panel suggests that the Environmental Management Committee consider the need to apply the CWQG and the SSWQO to the Rabbit Lake operation. Results of monitoring in Hidden Bay should indicate whether the application of these guidelines is necessary.

7.2 Spills

A number of presenters cited the spill of mine water at the Rabbit Lake Operation in 1989 as the reason that the proposed project was referred to a panel review. Cameco acknowledged that the spill did have a "profound impact" on its relationship with people in the North. In written and oral

presentations, the proponent described the improvements to contingency plans and procedures it has implemented since the spill to prevent further occurrences. The panel is of the opinion that the measures in place to prevent a similar spill are adequate and did not receive any information to the contrary.

Nevertheless, the panel was advised that a number of "minor" spills had occurred at the operation since 1989. One spill involved a truck driver who washed his truck with contaminated water from the mill. The issue is not so much the fact that spills have occurred but rather how they were reported. The panel was advised that certain spills were deemed to be "unreportable" if the spilled material did not enter the natural environment. In commenting on this issue, the AECB indicated that it is the practice for all spills to be reported, but it prefers the use of the term "incident" where there is no resultant environmental damage.

The panel concludes that the current mechanism of spill reporting apparently confuses the public and in some cases leads the public to mistrust the industry and regulatory agencies. The public has the right to be informed about spills at the Rabbit Lake operation in a timely and unambiguous manner. A method of classifying and reporting spills acceptable to the public is essential to the maintenance of public trust.

20. **The panel recommends that the Environmental Management Committee review the method of classifying and reporting spills and recommend any changes to ensure that the public is clearly informed of the nature and effects of all spills at the Rabbit Lake operation.**

7.3 Fish Habitat Compensation

Mining of the A-zone and D-zone orebodies would result in the loss of an estimated 14.2 hectares (ha) of fish habitat in Collins Bay. Detailed information on fish use of this habitat was not presented by the proponent. The Department of Fisheries and Oceans advised the panel that under its *Policy for the Management of Fish Habitat*, the proponent would be expected to enter into a *Fish Habitat Compensation Agreement* with the department to ensure that there is "no net loss" of the productive capacity of fish habitat. Further, Cameco would also be expected to apply for a *Fish Habitat Authorization* from the Minister of Fisheries and Oceans that would permit the destruction of fish habitat in Collins Bay. The panel notes that, should mining of the A-zone and D-zone be approved, the proponent should allow sufficient time to conduct the studies necessary to develop a compensation plan to the satisfaction of the Department of Fisheries and Oceans.

7.4 Financial Security

Provision of financial security to fund remediation of unforeseen damage to the environment and to ensure that the site is adequately decommissioned was an important issue at the hearings. The former was specifically addressed by the Hatchet Lake Band, which requested that a trust fund be

established to guarantee that any environmental damage be adequately cleaned up. The band proposed that this fund be administered by a board that includes representation from the community. In response, Cameco indicated that both the Saskatchewan and Canadian mining associations are working towards development of some form of an insurance or indemnification system. Further, Cameco indicated that it had initiated discussions with northern communities, including Wollaston Lake, about the establishment of a warranty against environmental damage. The panel encourages these efforts by Cameco.

Approval of a mining project is based on the understanding that the site can be decommissioned acceptably. After decommissioning and following a period of post-decommissioning monitoring, responsibility for the Rabbit Lake site will revert to Saskatchewan. The possibility that the site and associated wastes could become a public liability, as is the case with the Gunnar mine, is a serious public concern. The nature of this concern is twofold. First, the proponent may not have adequate resources to decommission the site, or changes in company profitability or ownership may affect the availability of these funds. Second, the company may abandon the site before the long-term effects of the wastes are known, leaving the government responsible for cleanup. In response to these issues, the Saskatchewan Environmental Society proposed that Cameco post two bonds, one to cover the costs of decommissioning and the second to cover long-term monitoring and maintenance of the site following abandonment.

Cameco estimated that decommissioning and reclamation of the Rabbit Lake operation would cost \$17.5 million. Further, Cameco stated that its policy on financial commitment for decommissioning and reclamation costs would be to accrue provisions for these costs and to have cash flows and financial liquidity to fund this work as required. Cameco indicated that at the end of 1992, it had a total accounting provision of \$45.8 million for decommissioning and reclamation of all of its operations.

The panel concludes that the proponent's accounting approach does not provide sufficient certainty that adequate funds would be available at the time of decommissioning.

Although final decommissioning of the site cannot occur until mining and milling of the ore are completed, certain aspects of the operation can be decommissioned now. For example, decommissioning of the B-zone pit and the original Rabbit Lake tailings pile has already been initiated. Further, Cameco proposed a number of studies to identify decommissioning options for other aspects of the operation. The panel encourages these initiatives, since they will reduce the amount of work, and therefore funds, required to finally decommission the site. If the proponent can demonstrate that various aspects of the operation have been successfully decommissioned, then public confidence and trust in Cameco's ability and commitment to decommission the site should increase. As previously recommended, the involvement of the Environmental Management Committee in developing a comprehensive decommissioning plan is essential to ensure that there is public input into this plan.

The AECB is proposing to revise the *Uranium and Thorium Mining Regulations* under the *Atomic Energy Control Act* to ensure that the costs of decommissioning of current and future licensed uranium mining facilities would be borne by the licensee and not by the public. However, the information supplied by the AECB states that these amendments "...**will not ensure that funds are available at the time that any decommissioning work is required to be carried out as that would require direct acquisition by the crown of a licensee's assets. The power to acquire assets can only be obtained through legislation, which the AECB will pursue as soon as possible.**" The AECB is currently consulting with stakeholders on these proposed revisions.

The panel concludes that the proposed amendments to the *Uranium and Thorium Mining Regulations* may not be sufficient to satisfy the concerns raised by many presenters. It is the panel's view that bonding, or other forms of financial security that cannot be used by the company except for decommissioning, is required.

21. The panel recommends that the Minister of Natural Resources consider either proposing amendments to the *Atomic Energy Control Act* or tabling other legislation that will provide for bonding or an equivalent form of financial security for decommissioning of the Rabbit Lake operation.

8 OTHER ISSUES

The issues addressed below merit comment, even though they are beyond the panel's mandate, since they raise policy and procedural issues that deserve further consideration by those responsible for reviews in these areas.

8.1 Public Review Process

Panel Mandate and Issues Concerning Nuclear Fuel

As the panel stated in the hearings, its terms of reference directed it to consider the environmental, health, safety, and socioeconomic impacts of the proposed uranium mining facility at Rabbit Lake. These terms of reference explicitly precluded the panel from examining the relative merits of generating electricity or the policies of the governments of Canada or Saskatchewan concerning uranium mining, uranium exports and nuclear non-proliferation.

Most presenters therefore focused their comments on the specific project under review. Some participants, however, felt compelled to express their views on a range of issues including energy options facing Canadians; the use of full-cost accounting to gauge the efficacy of uranium mining; the nuclear fuel cycle; disposal of high-level nuclear waste; the advisability of mining uranium when its price is low; and the end use of uranium.

The frequency with which participants voiced fundamental concerns about the link between uranium mining and the end use of the product raises two key points meriting comment. First, such concerns suggest the public is worried about nuclear war and deeply sceptical about Canadian and international safeguards against non-proliferation of nuclear weapons. Second, these concerns reveal that many participants believe that it is only through the environmental assessment of specific projects that they can participate in deliberations about energy and related policy choices.

In fact, both ongoing policy discussions within Saskatchewan and Canada, and the federal policy and program environmental review process, grant citizens the opportunity to make their views on these matters known. As such, these presentations seem to indicate that the other processes are not fully satisfying citizens' needs to be heard. Perhaps such needs could be met, in part, if greater efforts were made to inform citizens of their right to participate in these reviews.

In sum, while the panel does not deal substantively with these issues in this report, it does wish to indicate that these thoughtful and diverse viewpoints, documented in the transcripts, are a rich record of public views which those undertaking policy reviews in these areas would be well advised to consult.

Quality of the Environmental Impact Statement

A number of presenters expressed concern about the quality of the documents supplied by the proponent. Specific concerns were that some of the information in the 1992 revised EIS was incomplete and out-of-date. Another frequent criticism of the EIS was that it was not reader-friendly. Indeed, several participants in the public hearings cited these shortcomings as impediments which made it more difficult for them to analyze and evaluate the proposal under review.

The panel notes the concerns and understands the frustration expressed by these presenters. The panel also found the weaknesses made the environmental assessment process more demanding. In fact, in November 1992 and in May and June 1993, the panel had the proponent submit supplemental information to overcome these shortcomings.

The panel believes that the sheer volume of documents, as well as the difficulty of reading them as a whole, partially explains why more than a few presenters admitted that they had either not consulted or not understood these documents.

In general, the panel concludes that proponents would be well advised to devote the necessary time and effort to ensure that EISs are clear, complete and up-to-date. This extra initial effort could well save all parties considerable work and worry later in the assessment process.

Two Uranium Mining Panels

Even though the panel chair drew a clear distinction between this review and the federal/provincial panel examining separate projects in different northern locations, the existence of two panels concerned a number of participants. Essentially, these concerns were fourfold. First, some presenters raised issues such as revenue sharing that were pertinent in the other review but beyond this panel's scope. Second, and related to the first, a number of presenters expressed disappointment that provincial government representatives did not attend the hearings to answer their questions on provincial issues related to the Rabbit Lake proposal. Third, some presenters criticized governments for creating duplication and thereby spending public funds poorly. Finally, the fact that the two reviews were staged within a matter of months of one another appeared to have drained certain participants and thus may have diminished the quality of certain presentations to this panel.

Time Available for Public Hearings

In contrast with those who viewed this review as somewhat repetitive, some presenters expressed frustration with the amount of time available for the public hearings since, in their view, not all the salient issues raised had been discussed – let alone analyzed – in sufficient detail.

The panel recognizes that some participants found the public hearing process restricting because it involved detailed discussions of a wide range of major issues in a relatively short period of time.

8.2 Provincial Issues Raised

Revenue Sharing

Several aboriginal northerners referred to the area around the proposed project as "Dené land". They stated that they should be compensated for the mine's intrusion, which would disrupt their traditional lifestyles and cause environmental, social, and physical harm to their peoples. In addition to direct payments to trappers disturbed by the project, these presenters argued that they are entitled to other compensation from Cameco and to a larger share of the revenue generated by mining in the area.

Revenue sharing is a long-standing goal of residents of northern Saskatchewan. Several independent reviews have advocated this. For example, both the Cluff Lake and Key Lake Boards of Inquiry, in 1978 and 1981 respectively, recommended that revenues be shared with northerners. In this review, a number of presenters in southern Saskatchewan endorsed the principle of revenue sharing for aboriginal northerners since they viewed it is a matter of natural justice. Furthermore, spokespersons for the uranium industry in the province and the proponent expressed support for this goal, noting, however, that this issue primarily involves the provincial government and northerners.

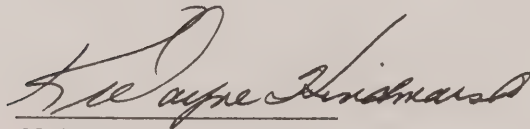
The panel notes these viewpoints and expresses the hope that the appropriate government agencies will take action to address this issue soon.

9 RECOMMENDATIONS

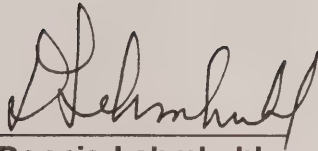
1. The panel recommends that full-production underground mining at Eagle Point be allowed to proceed under the conditions described within the report.
2. The panel recommends that mining of the A-zone and D-zone orebodies not proceed until information on waste-rock management and decommissioning is obtained and until Cameco has demonstrated that both short- and long-term adverse environmental impacts are mitigable.
3. The panel recommends that the Joint Review Group be restructured and expanded to create an Environmental Management Committee for the Rabbit Lake operation. The panel recommends that the AECB consult directly with stakeholders to establish the nature of their representation. Further, non-governmental participants should be compensated for their time and out-of-pocket expenses. The panel suggests that funds collected by government from the industry be used to finance these expenses.
4. The panel recommends that the Environmental Management Committee and the proponent determine and implement mechanisms for greater community involvement in the monitoring program.
5. The panel recommends that the AECB and other appropriate agencies make their services available to the communities to assist in the development and implementation of education and training programs.
6. The panel recommends that Cameco develop a waste-rock management plan for the A-zone and D-zone orebodies and that mining of these orebodies not proceed until the plan has been reviewed and approved. The plan should include the following essential elements:
 - a) a waste-rock classification scheme that can be justified on the basis of environmental protection and on meeting the ALARA principle;
 - b) confirmation that the proposed classification scheme will separate waste rock reliably from special waste and ore;
 - c) impact predictions that fully consider the conditions in the natural environment that will receive the waste; and
 - d) monitoring requirements to determine if the predictions are correct, to identify impacts not predicted and to provide data for the development of decommissioning plans.
7. The panel recommends that the Environmental Management Committee develop criteria to evaluate the proposed waste-rock management plan.
8. The panel recommends that Cameco implement a comprehensive monitoring and assessment program for the Rabbit Lake tailings pit. As part of this program, Cameco should undertake the following tasks:
 - a) Assess whether the properties of the tailings are consistent with those used when the facility was designed.
 - b) Calibrate and update predictive models on contaminant transport in the receiving environment using data from field testing of the B-zone tailings, Rabbit Lake tailings, Rabbit Lake waste rock and B-zone waste rock.
 - c) Determine the appropriate tailings' properties, including permeability and porosity, by field testing.
 - d) Determine the permeability and relevant hydraulic properties of all surrounding rock units by field testing.
 - e) Define the quality of pore water in order to estimate the quality of water that may reach the receiving environment.
 - f) If the water cover option were to be selected for decommissioning the pit, predict the long-term quality of surface water and surrounding groundwater using three-dimensional flow or geochemical models.
 - g) Maintain a detailed inventory of the chemical and physical characteristics of tailings deposited in the facility.
9. The panel recommends that mining of A-zone and D-zone not proceed until the proponent has demonstrated that the B-zone pit and waste-rock pile can be decommissioned without significant adverse environmental impacts and that detailed plans for decommissioning of A-zone and D-zone pits and waste rock have been prepared and approved. The proponent should demonstrate that these plans meet the ALARA principle.
10. The panel recommends that Cameco initiate the studies required to develop a comprehensive decommissioning plan. In the panel's view, some of the essential elements in this plan are the following:
 - a) the evaluation of existing water-quality standards to determine whether these represent adequate targets for decommissioning or whether site-specific standards are required;
 - b) the development and validation of models to evaluate the environmental effects of various decommissioning options and the development of a decommissioning strategy that meets established targets;
 - c) the establishment of baseline conditions and determination of the nature and extent of a post-decommissioning monitoring program that will be used to evaluate the environmental effects of decommissioning activities; and

- d) an estimate of the time frame and financial resources required to complete the decommissioning program.
11. The panel recommends that Cameco investigate means to reduce the amount of water that requires treatment and the amount of freshwater used. These reductions would decrease contaminant loading to Hidden Bay and thus achieve the goal of the ALARA principle with respect to potential impacts on the biophysical environment. Investigation of water use at the Rabbit Lake operation should include the following:
- a) the consideration of improved milling and water-treatment processes that would result in lower contaminant loadings;
 - b) an investigation of ways to use uncontaminated mine-site runoff and mine water in the mill to reduce freshwater consumption;
 - c) the reassessment of groundwater inflows to the Eagle Point mine and, if approved, A-zone and D-zone mines to identify options for further reducing volumes of contaminated mine waters; and
 - d) the examination of alternative methods of placing tailings in the pit and operation of the facility to reduce the amount of contaminated water pumped from the facility.
12. The panel recommends that results of the crown-pillar monitoring program and any significant changes in the design of the pillar be provided to the Environmental Management Committee.
13. The panel recommends that, to rectify the inadequacies in the baseline and monitoring data, the Environmental Management Committee undertake a complete review of the current monitoring program and recommend changes to meet community, scientific and regulatory requirements.
14. The panel recommends that Cameco undertake a comprehensive baseline study that can be used to monitor and assess the effects of additional development at the Rabbit Lake site. The baseline study should meet the requirements developed by the Environmental Management Committee.
15. The panel recommends that Cameco implement a detailed monitoring program that meets the requirements developed by the Environmental Management Committee.
16. The panel recommends that the Environmental Management Committee identify research needs and establish communication with those (e.g., universities, research institutes) that have the resources and abilities to conduct the research.
17. The panel recommends that the Environmental Management Committee provide input into the design of engineering and monitoring programs and evaluate the results of these programs to identify any cumulative effects of additional development at Rabbit Lake and to recommend ways to address any impacts identified.
18. The panel recommends that the AECB complete the consultation process on the regulatory changes proposed in C-122 in a timely manner and make every effort to have the revised regulations in place before full-production mining begins at Eagle Point.
19. The panel recommends that Environment Canada's current review of the MMLER include an examination of the feasibility of regulating all toxic substances in the Rabbit Lake effluent. Further, any revision of the regulations should take into account current technology and the biological effects of effluent releases. The panel urges Environment Canada to complete this review and amend the regulations in a timely manner.
20. The panel recommends that the Environmental Management Committee review the method of classifying and reporting spills and recommend any changes to ensure that the public is clearly informed of the nature and effects of all spills at the Rabbit Lake operation.
21. The panel recommends that the Minister of Natural Resources consider either proposing amendments to the *Atomic Energy Control Act* or tabling other legislation that will provide for bonding or an equivalent form of financial security for decommissioning of the Rabbit Lake operation.

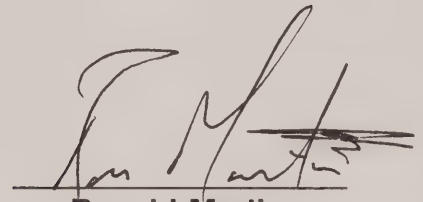
**RABBIT LAKE URANIUM MINE
ENVIRONMENTAL ASSESSMENT PANEL**

A handwritten signature in cursive script, reading "K. Wayne Hindmarsh".

**K. Wayne Hindmarsh
(Chair)**

A handwritten signature in cursive script, reading "Dennis Lehmkuhl".

Dennis Lehmkuhl

A handwritten signature in cursive script, reading "Ronald Martin".

Ronald Martin

APPENDIX A

PANEL MEMBER BIOGRAPHIES

DR. K. WAYNE HINDMARSH (Chair)

Dr. Hindmarsh is Dean of the Faculty of Pharmacy at the University of Manitoba.

Dr.³ Hindmarsh received a PhD from the Faculty of Pharmacy and Pharmaceutical Sciences at the University of Alberta in 1970. He was a professor in the College of Pharmacy at the University of Saskatchewan from 1979 to 1992.

Dr. Hindmarsh is a former president of the Pharmacy Examining Board of Canada and of the Canadian Society for Forensic Science, and is a member of the Canadian Pharmaceutical Association. As well, he is president and member of the Board of Directors of PRIDE (Parent Resources Institute for Drug Education) Canada Inc. He received the Meritorious Service Award of the Canadian Pharmaceutical Association in 1989, and the H. Ward Smith Award for toxicology research presented by the Canadian Society of Forensic Science in 1990.

Dr. Hindmarsh's research interests include drug and substance abuse, drug toxicity and poisoning.

MR. CHARLES W. PELLEY *

Mr. Pelley is an Assistant Professor in the Department of Mining Engineering at Queen's University. He is presently completing his Doctorate in Mining Engineering at McGill University. Mr. Pelley holds a Masters of Mining Engineering from McGill University and a Bachelor of Science in Geology from Memorial University.

Mr. Pelley's research interests include the development of new technology for materials handling in both open-pit and underground mines, and in the economic assessment of mine sequencing strategies. Mr. Pelley has extensive experience in the mining industry and has held a number of senior operational positions with several Canadian mining companies.

DR. DENNIS LEHMKUHL

Dr. Lehmkuhl is Professor of Biology at the Department of Biology, University of Saskatchewan. He received his M.Sc. in zoology from the University of Montana and his PhD in entomology from Oregon State University.

Dr. Lehmkuhl has been a member of the faculty of the Department of Biology since 1969, has taught extensively in the field of biology, and is well-respected in the field of entomology. He has numerous publications on the functioning of northern aquatic ecosystems, including entomological functions, and has research interests in potential environmental disturbances of these ecosystems. Dr. Lehmkuhl is actively involved in a number of professional organizations, and has served as chairman of the Review of Environmental Impact Studies Committee with the Biological Survey of Canada. He has also acted as referee for editors of a number of biological journals, including the Canadian Water Resources Journal and the Canadian Journal of Zoology.

DR. RONALD MARTIN

A member of the Fond-du-Lac Band, Dr. Martin is a dentist, currently living in Saskatoon, Saskatchewan. He is actively engaged in establishing dental services to native communities throughout Saskatchewan. Dr. Martin graduated from the College of Dentistry at the University of Saskatchewan in 1990 and performed an internship providing dental services to the communities of Fond-du-Lac and Black Lake, Saskatchewan. He received an Advanced B.A. in Sociology and an Advanced B.Sc. in Anatomy from the College of Arts and Science of the University of Saskatchewan. Dr. Martin has also completed a Native Law Program at the University of Saskatchewan.

Dr. Martin's professional interests lie in establishing dental service clinics for native communities throughout Saskatchewan. He recently completed a one-year term with the Northern Outreach Program, University of Toronto, providing dental service to the people living in the area of Moose Factory, Ontario.

* Mr. Pelley resigned from the panel prior to the hearings phase for medical reasons.

APPENDIX B

SECRETARIAT AND TECHNICAL SPECIALISTS

Panel Secretariat

John Mathers	Executive Secretary
John McEwen	Technical Advisor
Mike Lascelles	Technical Advisor
Jackie Kelly	Office Administrator

Technical Specialists

Clifton Associates Ltd.
Uranium Mining Engineering Issues

Ecologistics Limited
Cumulative Effects

Environmental-Social Advisory Services (ESAS) Inc.
Employment and Socioeconomic Issues

Moore Chamberlin and Associates
Social Health Issues

APPENDIX C

TERMS OF REFERENCE FOR AN ENVIRONMENTAL ASSESSMENT REVIEW OF THE PROPOSED DEVELOPMENT OF THE URANIUM MINING FACILITY AT RABBIT LAKE

Mandate

The environmental assessment panel is to undertake a review of the environmental, health, safety and socio-economic impacts of the proposed development of the uranium mining facility at Rabbit Lake in northern Saskatchewan. The panel will include in its review:

- the short and long-term impacts of the proposed development, spanning the construction phase, operating period, decommissioning and post-decommissioning phases;
- the cumulative impacts of the existing operation and the proposed development;
- the impact of employment and socio-economic opportunities afforded northern residents by the proponent and the measures necessary for implementation of those opportunities;
- the adequacy of measures proposed by the project proponent to protect environmental quality and to safeguard worker health and safety, and whether the measures can be expected to meet the requirements of Canadian and Saskatchewan law, regulations and policies applicable to uranium mining;
- the adequacy of monitoring, enforcement and compliance systems to ensure the measures necessary for mitigating adverse impacts can be implemented; and
- the benefits afforded by the proposal.

The panel shall consider and report on the environmental and socio-economic acceptability of the project. If the panel concludes that the project is acceptable, it may recommend terms and conditions under which the project could proceed. If the panel concludes that the project is unacceptable, it shall provide its rationale for this recommendation.

The mandate of the panel does not include a review of the relative merits of the various means of generating electricity or

the policies of the governments of Canada or Saskatchewan concerning uranium mining, uranium exports and nuclear non-proliferation.

Review Procedures

Detailed written procedures for conducting the review shall be established by the panel and made available to the public.

Technical Experts

The panel may secure the services of independent technical experts to assist and advise on complex technical and/or socio-economic issues related to its mandate. Such experts will also be available to respond to inquiries from review participants.

Stages of the Review

1. Review by the panel and the public of the Environment Impact Statement (EIS) submitted by the proponent.
2. Should the panel, after reviewing the EIS and considering public comments, deem the EIS deficient, it may request additional information from the proponent.
3. Once the panel is satisfied with the information provided, it will schedule and announce public hearings on the project. The location of the hearings will be decided by the panel.
4. The panel will conduct the hearings in a non-judicial but structured manner to allow for a full and fair examination of all information received by the panel and to solicit public comment on matters relevant to its mandate.
5. When the panel is in a position, following the public hearings, to provide a report on its findings, conclusions and recommendations, it will submit the report to the Ministers of Environment and of Energy, Mines and Resources. All reasonable efforts should be made to have this report completed by the summer of 1992.

APPENDIX D

BIBLIOGRAPHY OF REVIEW DOCUMENTS

- *Environment Impact Statement, Collins Bay A-zone, D-zone and Eagle Point Development, Revised 1992*. Prepared by Environment and Safety Department, Cameco Corporation.
- *Addendum, Environment Impact Statement, Collins Bay A-zone, D-zone and Eagle Point Development*. Prepared by Environment and Safety Department, Cameco Corporation, March, 1993.
- *Response to Panel Questions and Concerns on the Addendum*. Prepared by Environment and Safety Department, Cameco Corporation, May, 1993.
- *Compilation of Submissions on Environmental Impact Statement, Collins Bay A-zone, D-zone and Eagle Point Development*. Prepared by Rabbit Lake Uranium Mine Environmental Assessment Panel, November, 1992.
- *Transcript of the Public Hearings held by the Rabbit Lake Uranium Mine Environmental Assessment Panel on the Collins Bay A-zone, D-zone and Eagle Point Development, June 8 – July 5, 1993*.
- *Written Submissions received during the Public Hearings on the Collins Bay A-zone, D-zone and Eagle Point Developments* (see Appendix F).
- *Assessment of Social Health Issues addressed in the Rabbit Lake Uranium Mine Environmental Impact Statement*. Prepared for the Rabbit Lake Environmental Impact Assessment Review Panel by Moore Chamberlin and Associates, Saskatoon, Saskatchewan, 1992.
- *Final Report, Cluff Lake Board of Inquiry*, E.D. Bayda, Chairman, 1978.
- *Key Lake Board of Inquiry Report*, R.W. Mitchell, Chairman, 1981.

APPENDIX E

SCHEDULE OF PUBLIC HEARINGS - 1993

June 8	Black Lake	June 14-16	Saskatoon
June 9	Fond-du-Lac	June 17-18	Regina
June 10	La Ronge	June 28-30	Saskatoon
June 11	Prince Albert	July 5	Wollaston Lake

APPENDIX F

SUBMISSIONS TO THE PANEL

Eli Adam	Greg Chatterson
Anderson/Fast Marketing Solutions (Doug Fast)*	Citizens Concerned About Free Trade (David Orchard)*
Association of Consulting Engineers of Saskatchewan (E.J. Hinz)*	Clifton Associates Ltd. (Wayne Clifton)*
Association of Professional Engineers of Saskatchewan (Reg Briggs)*	Fred Clipsham*
Athabasca Airways (Tim Glass)*	Ann Coxworth*
Atomic Energy Control Board (Larry Chamney, George Jack, Rick McCabe, Mary Measures, Kevin Scissons, Tom Viglasky)*	CUSO (Don Kossick)*
BB Health Physics Services (Dennis Brown)*	Dene Airways (Dave Webster)
Linda Batty	Able Denechezhe
Bearing and Transmission Ltd. (Paul Zehr)*	Discovery Travel (Bob Nicholson)*
Ed Benoanie*	Robert Doucette*
Gordon Blaylock, Martin Marietta, Oakridge Laboratory*	Economic Development Authority of Saskatoon (Jim Yuel)*
Edwin Bonnaley	Energy Mines and Resources Canada (Richard Williams)*
Ann Boulton	Environment Canada (Dennis Lawson)
Carla Braidek*	Environmental Monitors of the Athabasca Region (Dennis Robillard)*
Brankohle Transport (Donna Goertzen)*	Kim Epp*
Douglas Bruno	Fisheries and Oceans Canada (Bruce Fallis)*
Chris Buhler*	Beryl Forgay*
Cameco Corporation (Bill Allan, Garry Anderson, Stan Frost, Gerald Grandey, Wayne Iron, Jamie McIntyre, Walter Smith, Bob Wyka)*	Maria Fortugno*
Canadian Coalition for Nuclear Responsibility (Gordon Edwards)*	Stefania Fortugno*
Canadian Nuclear Association (Ian Wilson)*	Joe Froese
Canadian Nuclear Society (Anis Dagher)*	Louise Gagne*
Caribou Management Board (Ben Denechezhe)*	David Geary*
Gordon Carle	Isabelle George*
Srini Chary*	Gibson Holdings Ltd. (Curtis Gibson)*
	Hatchet Lake Indian Band (Jean-Marie Tsannie, Jack Bell)*
	Shirley Hauta*
	Ralph Helmuth*
	David Hiebert*
	Cathy Holslander*
	IW Camp Site Caterers (William Smith)*

Industrial Mechanical Corporation (J.A. Wall)*
 Inter-Church Uranium Committee (Philip Penna, Marvin Resnikoff)*
 Intergroup Consultants Ltd. (Cam Osler)*
 Inuit Tapirisat of Canada (Jamie Kneen)*
 Walter Keyes*
 George Khachatourians*
 Kitsaki Development Corporation (Joe Roberts)*
 Heather Kleiner*
 Helen Kobelsky*
 Croft Kyla
 Jim Laban
 Terry LaBrash*
 Lafarge Canada Inc. (Ken Ward)*
 Marlene LaRocque*
 LaRonge and District Chamber of Commerce (Peter Kelly)*
 LaRonge Economic Development Committee (Ron Spooner)*
 Town of LaRonge (Morris Gabrush)*
 Victor Lau
 Steve Lawrence
 Bart MacDonald
 John MacDonald
 Niel Martin
 Madge McConnell*
 Alex Mercredi
 Louis Mercredi
 Napoleon Mercredi
 Bill Metke
 Mid-north Mine and Safety Supply (Martin Arndt)*
 Millennium III Properties Corp. (E.J. Kearley)*
 Linda Murphy
 David Myers*
 Norpro Developments (Scott Christianson)*
 Jan Norris*
 North Yanke Transfer Ltd. (Russell Marcoux)*
 Northern Industrial Plating (Heidi Schellenberger)*
 Northern Resource Trucking (Roger Olysowsky)*
 Dan Parrott
 The Partnership (Jim Woytiuk)*
 James Penna*
 Marion Penna*
 Grace Pine*

Michael Poellet*
 Brent Pomeroy*
 Porcupine Plains Opportunities Program (Carl Kwiatowski)*
 Prince Albert Development Corporation (Duane Hiebert)*
 Tim Quigley*
 Peter Robillard
 Simon Robillard
 SENES Consultants Ltd. (Douglas Chambers)*
 SRK Consultants (Andy Robertson)*
 Saskatchewan Environment and Resource Management (Ron Zukowsky)*
 Saskatchewan Environmental Society (Peter Prebble)*
 Saskatchewan Government Employees Union (Fiona Bishop)*
 Saskatchewan Mining Association (Garth Moore)*
 Saskatchewan Natural History Society (Jim Elliott)
 Saskpower Corp., Northern Enterprise Fund (Ben Siemens)*
 Saskatoon Chamber of Commerce (Dwight Percy)*
 Saskatoon Indigenous Coalition (Jackie Barclay, Dan Stifle)*
 Saskwatch (Paul Hanly, Larry Morris)*
 Maisie Shiell*
 Siemens Transport Ltd. (Brian Smith)*
 Adelle Smillie*
 Miriam Smith*
 Snake Lake Construction (Rene Rediron)
 Carol Stang*
 Gabriel Steene
 J.G. Strnad*
 Stephanie Sydiaha*
 Synergy Today (Bill Childerhose)*
 Allan Taylor*
 Patricia Thomas*
 Freddie Thorassie
 Thyssen Mining Ltd. (Andy Fern)*
 Uranerz Exploration and Mining Ltd. (Hikmet Akin, Roland Loewer)*
 Uranium Saskatchewan Association (Tim Meadly)*
 Van Waters and Rogers Ltd. (Lionel DeBray, Doug James)*
 Visions North Community Futures Committee (Angus Pratt)*
 Karen Weingeist
 Criss Wiercinski*

* A written submission was provided and is available for public review.

APPENDIX G

GLOSSARY

Active face	The surface exposed by excavation at the end of a tunnel heading or at the end of a full-size excavation.	Filter cake	The compacted solid or semi-solid material separated from a liquid and remaining on a filter after pressure filtration.
Alpha particle	A positively-charged particle emitted by a radionuclide and composed of two protons and two neutrons.	Gamma radiation	A high energy photon, especially as emitted by a nucleus in a transition between two energy levels.
Beta particle	A negatively-charged particle emitted from the nucleus of an atom, with a mass and charge equal in magnitude to that of an electron.	Geochemistry	A science that deals with the chemical composition and chemical changes in the solid matter of the earth.
Clarifier	A centrifuge, settling tank or other device for separating suspended solid matter from a liquid.	Geologic strata	Beds or layers of rock.
Crown pillar	A undisturbed rock mass left between the top of an underground excavation and the surface.	Gray	One gray is the amount of energy imparted by radiation to a unit of mass of matter such as tissue.
Cumulative effect	The result of a series of successive actions or impacts; in the context of the environment, a succession of impacts from the same or different sources that, taken together, result in a change to an ecosystem.	Groundwater	All water below the ground surface.
Curie	A unit of radioactivity defined as that quantity of any radioactive nuclide which has 3.7×10^{10} disintegrations per second.	Hydraulics	A branch of science that deals with the motion of liquids.
Cut-off grade	The lowest grade of mineralized rock that is quantified as ore in a given deposit.	Hydrogeology	A science that deals with the character, source and mode of occurrence of underground water.
Decline	A downward slope.	Hydrology	A science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere.
Decommissioning	The process of removing a facility from service.	Infiltration	The deposition of a mineral among the pores of a rock by the permeation of the percolation of water carrying it in solution.
Dose	The amount of energy imparted by ionizing particles to a unit of mass of irradiated material at the point of interest.	Leachate	A solution or product produced by a liquid percolating through the soil or other medium.
Dosimeter	An instrument that measures the total dose of radiation in a given period.	Limnology	The scientific study of the physical, chemical and biological conditions in fresh waters.
Dyke	A barrier constructed to prevent the passage of water.	Microinvertebrate	One of a group of animals without a backbone; generally consisting of plankton, bacteria and protozoa.
Epidemiology	A branch of medical science that deals with the incidence, distribution and control of disease in a population.	Mucking	The operation of loading broken rock by hand or machine usually in shafts or tunnels.

Nuclide	A species of atom characterized by the number of protons, number of neutrons, and energy content in the nucleus, or alternatively by the atomic number, mass number and atomic mass.	Special waste	Waste requiring greater levels of treatment due to the nature or concentration of contaminants it contains.
Overburden	Material overlying a deposit of useful geological materials or bedrock.	Stakeholder	Government or non-government parties with an interest in or responsibility for a project under review.
Pore water	Free water present in the soil or other materials.	Stave tank	A tank constructed of narrow strips of wood placed edge to edge to form the sides.
Radioactivity	The property of certain unstable nuclides to spontaneously undergo nuclear transformations that result in the emission of ionizing radiations.	Stope	A step-like excavation underground for the removal of ore that is formed as the ore is mined in successive layers.
Radionuclide	A nuclide that exhibits radioactivity.	Tailings	Residue produced during the milling of ore consisting of finely ground rock and chemical precipitates.
Radon	A heavy radioactive gaseous element formed by the disintegration of radium.	Taxonomy	The orderly classification of plants and animals according to their presumed natural relationships.
Radon progeny	The four radioactive, short-lived decay products of radon: polonium-218, lead-214, bismuth-214, and polonium-214.	Voucher specimen	A sample or specimen permanently retained and accessible in the event that reanalysis is necessary or confirmation of the identification is required.
Raise	A vertical or inclined opening or passageway connecting one mine working area with another at a higher level.	Working level	One working level corresponds to a concentration of 100 picoCuries per litre of air.
Scoop tram	A vehicle used to remove broken ore from the bottom of the stope.		
Seal water	Water maintained under pressure to provide a seal between a contaminated fluid and a bearing to prevent contaminants from reaching the bearing.		

